Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Subfield: Life science and engineering for agriculture, environment science, food and the environment, sustainable development,

ParisTech School:AgroParisTech / ABIES Doctoral School

Title:Development of new insect-pest control strategies aimed at enhancing the impact of biological control agents by reducing the immunocompetence of the host.

Advisor(s): Dr. Vincent Sanchis-Borja, e-mail: vincent.sanchis-borja@inra.fr , Web site: http://www.micalis.fr/micalis_eng/Poles-and-teams/Pole-Risk/GME-Lereclus/Team-members/Vincent-Sanchis-Borja

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

The insect gut microbiota is the first organ and barrier in contact with ingested toxins and microbes. Therefore, the integrity of the intestinal microbiota is likely to be of high importancein modulating the interactions between the host and intestinal pathogens, and for the capacity of an insect to tolerate the presence of a pathogen. Indeed, in the model insect *Galleria mellonella,*it has been recently shown thata colony resistant to *Bacillus thuringiensis*(Bt)showed a modified bacterial community (Dubovskiy et al. 2016, *Virulence*). Moreover it is well known and thatin *Spodopteralittoralis,*the gut bacterium *Enterococcus. mundtii* produces an antimicrobial peptide that strongly inhibits some potentially pathogenic organisms (Shao, et al., 2017, *Cell Chemical Biology*).However, another report claimsthat the insect gut microbiota of *S.littoralis*could enhance the impact ofBt (Caccia et al, 2016, *Proc Natl Acad USA*) Therefore, the role of the gut microbiota in infection processes in insects, either naturally occurring or following spreading of biological control agents (BCAs), remains contradictory and fragmented and is far from clear.Here, we propose to use the larvae of*G.mellonella*, to assess the virulence and infection process ofBtand of its Cry toxins that are widely used in organic farming in mosquito control. The aim in this project is to focus on the role of insect microbiome in host resistance against colonization and infection to make insect-pests more susceptible to pathogen infection.We have already information on the microbiota of *G.mellonella* and we can rear axenic insects and modify the microbiota with antibiotics. In this project we will: 1) use *Gm* to analyse how the gut microbiota interfere with pathogens entering by the oral route, such as *Bacillus thuringiensis* (Bt) 2) Determine the correlation between artificial perturbations of gut microbiota and changes in the physiological and immunological state of the insect 3) Manipulate the gut microbiota to establish which components of the insect microbiome are parasitic or mutualistic 4) Use metagenomic and RT-qPCR approaches to identify the mechanistic impact of the pathogen on antagonistic or synergistic cross-interactions of the microbiota on insect immunity. This model system is anticipated to provide insights into the importance of septicemia in the killing mechanism mediated byBtbiopesticides and could provide a sound foundation for developing new insect control strategies aimed at enhancing the killing-efficacy of biocontrol agents by reducing the immunocompetence of the host.

Required background of the student: A general background in genomic sciences including classes in genetics, molecular biology, biochemistry and preferably in bioinformatics/statistics for analysis of sequencing data.

A list of 5(max.) representative publications of the group:

- Attieh Z., Kallassy M., Rejasse A., Courtin P., Gomperts-Boneca I., Chapot-Chartier M-P., Sanchis V. and El Chamy L. (2018).Of Bacilli and Flies: D-alanine esterification of teichoic acids impedes the sensing of peptidoglycan by the host innate immune system. Submitted to Cell Host & Microbes.

- Kamar R**,** Réjasse A**,** Jéhanno I**,** Attieh Z, Courtin P., Chapot-Chartier M-P, Nielsen-Leroux C**,** Lereclus D**,** El Chamy L, KallassyAwad M**,** Sanchis-Borja V. (2017). DltX of *Bacillus thuringiensis* is essential for D-alanylation of teichoic acids and resistance to antimicrobial response in insects. Frontiers in Microbiology. 8:1437. doi: 10.3389/fmicb.2017.01437.

- Patino-Navarrete Rand Sanchis V. (2017) Evolutionary processes and environmental factors underlying the genetic diversity and lifestyles of *Bacillus cereus* group bacteria.Research in Microbiology. 2017 May;168(4):309-318. doi: 10.1016/j.resmic.2016.07.002. Epub 2016 Jul 16.

-Kamar R**,** Gohar M**,** Jéhanno I**,** Rejasse A**,**KallassyAwad M, Lereclus D,Sanchis V,Ramarao R**.** (2013). Pathogenic potential of *Bacillus cereus* strains as revealed by phenotypic analysis. J. Clin. Microbiol. 51(1): 320-323.

- Song F, Peng Q, Brillard J, Buisson C**,** de Been M, Abee T, Broussolle V, Huang D, Zhang J, Lereclus D**,** Nielsen-Leroux C**.** (2012). A multicomponent sugar phosphate sensor system specifically induced in *Bacillus cereus* during infection of the insect gut. FASEB J. 26(8): 3336-3350.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):***
1. Life and Health Science and Technology

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)
Veterinary sciences
Title:
Interactions cells/*Anaplasma phagocytophilum*
ParisTech School:
Ecole Nationale vétérinaire d'Alfort (EnvA)
Advisor(s) Name: Nadia Haddad and Henri-Jean Boulouis
Advisor(s) Email:nadia.haddad@vet-alfort.fr /henri-jean.boulouis@vet-alfort.fr

(Lab, website):https://www6.inra.fr/bipar
UMR BIPAR Enva/Anses/Inra

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
Anaplasma phagocytophilum is a zoonotic tick-borne bacterium, which also affects ruminants with important economic losses in Europe and in China.*In vivo*, this strict intracellular bacterium is found inneutrophilic granulocytes (NG), but the niche tissues where it can persist and multiply have not yet been identified.We are currently working on the development of a neo-natural model of*in vitro*survival of NG, which will allow tracking the infection bystrains of different origins and answer questions about host specificity. This monitoring requires the ability to locate the bacteria during the infection. The PhD project has two components:
- *In vitro*, the identification of the relationships between the bacteria and the infracellular components involved in the interactions with the bacteria with different omics approaches.Production and characterization of monoclonal antibodies against *A. phagocytophilum* (presently missing) will allow tofollow-up cell infection (NG), using the capabilities of the confocal microscope that we just acquired.
- *in vivo*, thefollow-up of infection in both vertebrate hosts(mouse model) and tick tissues. A prerequisite will be obtaining a strain of *A. phagocytophilum* labeled with green fluorescent protein (GFP).

Required background of the student: (Which should be the main field of study of the applicant before applying)
Cellular biology and technology
A list of 5(max.) representative publications of the group: (Related to the research topic)
1: Gioia GV, Vinueza RL, Marsot M, Devillers E, Cruz M, Petit E, Boulouis HJ, Moutailler S, Monroy F, Coello MA, Gondard M, Bournez L, Haddad N, Zanella G.Bovine anaplasmosis and tick-borne pathogens in cattle of the Galapagos Islands. Transbound Emerg Dis. 2018 Oct;65(5):1262-1271. doi: 10.1111/tbed.12866.
2: Lagrée AC, Rouxel C, Kevin M, Dugat T, Girault G, Durand B, Pfeffer M, Silaghi C, Nieder M, Boulouis HJ, Haddad N. Co-circulation of different *A.phagocytophilum* variants within cattle herds and possible reservoir role forcattle. Parasit Vectors. 2018 Mar 9;11(1):163. doi: 10.1186/s13071-018-2661-7.
3: Dugat T, Haciane D, Durand B, Lagrée AC, Haddad N, Boulouis HJ. Short Report: Identification of a Potential Marker of *Anaplasma phagocytophilum* Associated withCattle Abortion. Transbound Emerg Dis. 2017 Oct;64(5):e1-e3. doi:10.1111/tbed.12508.
4: Dugat T, Zanella G, Véran L, Lesage C, Girault G, Durand B, Lagrée AC,Boulouis HJ, Haddad N. Multiple-locus variable-number tandem repeat analysispotentially reveals the existence of two groups of *Anaplasma phagocytophilum*circulating in cattle in France with different wild reservoirs. Parasit Vectors. 2016 Nov 22;9(1):596.

5: Dugat T, Loux V, Marthey S, Moroldo M, Lagrée AC, Boulouis HJ, Haddad N,Maillard R. Comparative genomics of first available bovine *Anaplasma phagocytophilum* genome obtained with targeted sequence capture. BMC Genomics.2014 Nov 17;15:973. doi: 10.1186/1471-2164-15-973.

Research Topic for the ParisTech/CSC PhD Program

1. ***Field (cf. List of fields below):*** Life Science and Engineering for Agriculture, Food and the Environment, Chemistry

Subfield: Analytical Chemistry and Food Safety

Title: Quest of Pesticides in Foodstuff by using High Resolution Mass Spectrometry: targeted and untargeted approach

ParisTech School: ED ABIES/AgroParisTech/ANSES

Advisor(s) Name: PARINET Julien, GUERIN Thierry
Advisor(s) Email: julien.parinet@anses.fr ; thierry.guerin@anses.fr
(Lab, website): https://www.anses.fr/en/content/laboratory-food-safety-maisons-alfort-and-boulogne-sur-mer

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Pesticides help to produce crops, but not without consequences for health of human beings. For this reason, regulations involving maximum residue limits (MRLs) have been implemented. It is accompanied by monitoring and control plans (PSPC) to ensure compliance with legislation by farmers and intermediates. Nevertheless, recent news alerts us on the fact that no system is perfect, explained by various reasons where the regulations are not respected. Recently, a number of high resolution mass spectrometry (HRMS) devices appeared on the market. These devices allow the detection of a large number of small molecules by exploiting the monoisotopic mass of the molecules and generating chemical fingerprints that require the use of bioinformatic tools. This type of approach makes it possible to respond to the lack of comprehensiveness of conventional analyzes through the so-called "untargeted" approaches. We propose to develop an analytical method on LC-HRMS and to add quantification to the latter on a pool of pesticides as wide as possible. It will be also essential to carry out the development of the extraction methods necessary for various food matrices. Finally, a sampling plan will be drawn and will be an opportunity to investigate through it the possible presence of contaminants not sought by conventional PSPCs. This work should demonstrate the versatility of the approach and thus improve the safety and the health of consumers.

Required background of the student: analytical chemistry, data mining, bioinformatic

A list of 5(max.) representative publications of the group:

- Validation of analytical methods for chlordecone and its metabolites in the urine and feces of ewes. Saint-Hilaire, M., Bertin, T., Inthavong, C., (...), Rychen, G., **Parinet, J**. Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences 1093-1094, pp. 66-76. **2018**
- Development and validation of an HPLC-MS/MS method with QuEChERS extraction using isotopic dilution to simultaneously analyze chlordecone and chlordecol in animal livers. Saint-Hilaire, M., Inthavong, C., Bertin, T., (...), Rychen, G., **Parinet, J.** Food Chemistry 252, pp. 147-153. **2018**
- Untargeted screening approach for low-level food contamination by pesticides using liquid chromatography coupled with high-resolution mass spectrometry: how to choose the best reference sample for an efficient pairwise comparison. **Parinet J., Guérin T.** Lavison-Bompard G. Submitted to Analytica Chimica Acta.
- Dom I., Biré R., Hort V., Lavison-Bompard G., Nicolas M., **Guérin T.** Extended Targeted and Non-Targeted Strategies for the Analysis of Marine Toxins in Mussels and Oysters by (LC-HRMS). Toxins, 10, 375, 1-22. **2018**

Research Topic for the ParisTech/CSC PhD Program

Field: Mathematics and their applications
Subfield: Computer science
Title: Agri-Food Model Exploration Using Interactive Machine Learning and Visualization: Application to Sustainable Food Supply
ParisTech School: The National Institute of Agricultural Research INRA (inra.fr)
Advisor(s): Nadia Boukhelifa: {nadia.boukhelifa@inra.fr, http://pfl.grignon.inra.fr/nb}, Evelyne Lutton:{evelyne.lutton@inra.fr, http://evelyne.lutton.free.fr/}
Lab: GMPA (team MALICES): https://www6.versailles-grignon.inra.fr/gmpa_eng/Research-teams/MALICES

Short description of possible research topics for a PhD:

The search space for exploring models and their parameters is huge. Model builders have to answer many questions prior to selecting a particular model or family of models, such as: Which parameters are more influential, which ones are more sensitive to noise? Which models better explain the data, and which ones make more sense? Although it is possible to explore and select models automatically, providing satisfying answers to the previous questions relies on direct feedback from domain experts, who often need to find the right compromise between multiple conflicting criteria.

Modelling frameworks that take into account human-model interactions at all model development stages are still a subject of ongoing research [2]. Robust human-model interfaces and visualization techniques are needed to bridge the gap between model specification & generation, and model inspection & validation. The aim of this thesis is to investigate suitable interactive visualization and machine learning techniques to explore agri-food models [4], and to exploit user feedback to steer this exploration towards "interesting" areas of the search space [1,3].

The application concerns sustainable complex agri-food systems [4], namely for cereal-based production. The applicant needs to work with data provided by the host institution, build on existing models, and create interactive machine learning and visualization techniques to explore the model space. He or she needs to evaluate their work with domain experts from the host institution.

Required background of the student:

Applicants need to have a master degree in computer science or related discipline. Candidates need to be proficient in a programming language such as Python, C++, or Java. Experience in machine learning and/or interactive visualization is an advantage. Knowledge in agri-food or the application domain is not required.

A list of representative publications of the group:

[1] N. Boukhelifa, A. Bezerianos, W. Cancino, and E. Lutton. 2017. Evolutionary visual exploration: evaluation of an IEC framework for guided visual search. Evol. Comput. 25, 1 (March 2017), 55-86.
[2] N. Boukhelifa, A. Tonda, I. C. Trelea, N. Perrot, and E. Lutton. 2017. Interactive Knowledge Integration in Modelling for Food Sustainability: Challenges and Prospects. ACM CHI workshop on Designing sustainable food systems. http://www.foodchi.org/wp-content/uploads/2016/12/99.boukhelifa_foodchi.pdf
[3] W. Cancino, N. Boukhelifa, and E. Lutton. EvoGraphDice: Interactive evolution for visual analytics. 2012. IEEE Congress on Evolutionary Computation, 1-8.
[4] N. Perrot, H. De Vries, E. Lutton, H. G.J. van Mil, M. Donner, A. Tonda, S. Martin, I. Alvarez, P. Bourgine, E. van der Linden, M. A.V. Axelos. 2016. Some remarks on computational approaches towards sustainable complex agri-food systems, Trends in Food Science & Technology, Volume 48, February 2016, Pages 88-101.

Research Topic for the ParisTech/CSC PhD Program

Field:Biology, Biophysics and Bio Chemistry

Subfield: Evolutionary biology

Title: Genomics-enabled evolutionary biology study of jumping genes

ParisTech School:Agroparistech

Advisor(s): Florian Maumus, florian.maumus@inra.fr

Host lab: URGI at French national institute for agricultural research, website

Short description of possible research topics for a PhD:
By integrating host genomes repeatedly in a stochastic manner, selfish genetic elements (SGEs - including viruses and transposable elements) can profoundly influence the biology of their hosts. They represent a predominant part of most eukaryotic genomes and constitute a major source of genetic and epigenetic changes. Friends or foes? The integration of SGEs in genomes causes deleterious mutations most of the time, but it occasionally mediates key evolutionary adaptations and transitions.
Plant genomes commonly comprise a significant proportion of transposable elements (TEs) (*e.g.* 80% in maize) and different superfamilies of TEs have been "populating" plant genomes under the form of repetitive genetic elements since the emergence of green plants, over one billion years ago. Although their impact on plant evolution is paramount, macro-evolutionary studies are lacking and the evolutionary secrets of theirsuccess largely remain to be unveiled.
The survival and success of TEs profoundly depends on their capacity to resist to therestraints applied by their host and to succeed in genetic adaptation and innovation. Indeed, TEs are the subject of substantial compositional constraints owing for instance to being targets of DNA methylation. In the other hand, continuous evolution of TEs is required for their survival to adapt to theirhost biology and to the environment, for instance by convergence of regulatory sequences towards proper host transcription factors binding sites.
In this context, the applicant is expected to perform a large-scale bioinformatics analysis to collect TE sequences from dozens of plant genomes. Making the most of this data, the applicant will address the coevolution of TEs with plants, and more specifically attempt to link TE regulatory elements to the evolution of cis-acting elements and of gene networks.

Required background of the student: Bioinformatics, Genomics

List of representative publications of the group:
1. Maumus F, Quesneville H: **Impact and insights from ancient repetitive elements in plant genomes**. *Curr Opin Plant Biol* 2016, **30**:41-46.
2. Jouffroy O, Saha S, Mueller L, Quesneville H, Maumus F: **Comprehensive repeatome annotation reveals strong potential impact of repetitive elements on tomato ripening**. *BMC Genomics* 2016, **17**(1):624.
3. Maumus F, Quesneville H: **Deep investigation of Arabidopsis thaliana junk DNA reveals a continuum between repetitive elements and genomic dark matter**. *PLoS One* 2014, **9**(4):e94101.
4. Maumus F, Quesneville H: **Ancestral repeats have shaped epigenome and genome composition for millions of years in Arabidopsis thaliana**. *Nat Commun* 2014, **5**:4104.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below):

1. Environment Science and Technology, Sustainable Development, Geosciences
2. Life Science and Engineering for Agriculture, Food and the Environment
3. Energy, Processes

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)
Bioprocesses,
Microbial ecology, Molecular biology,
Analytical chemistry, Metabolomics,
Biostatistics

Title: Improving the operation of anaerobic digesters: high-throughput molecular ecology approaches to understand and prevent disturbances occurring during co-digestion.

ParisTech School: AgroParisTech

Advisor(s) Name: Laurent Mazéas and Olivier Chapleur, research scientists at HBAN Research Unit, Irstea, FRANCE

Advisor(s) Email:laurent.mazeas@irstea.fr and olivier.chapleur@irstea.fr
(Lab, website):http://www.irstea.fr/en/chapleur
Short description of possible research topics for a PhD:
Anaerobic digestion (AD) is a microbial bioprocess of degradation of the organic matter which ultimatelyproduces biogas rich in methane that can be converted to electrical and thermal energy. It is used to recover different types of organic waste. However AD is very sensitive to different types of perturbations that can lead to process failure.
In this PhD project we want to focus on perturbations of AD that can occur during co-digestion of different substrates by using the omic methodologies. Laboratory experiment simulating digesters disruption will be performed. DNA sequencing will enable to follow the microbial dynamics after the perturbation and metabolomic analyses will describe evolution of metabolic pathways. The analysis of these omics data by biostatistical toolswill allow extracting the relevant correlations between the various types of data to identify the causes ofthe failure and propose strategies of successful management to improve co-digetion. In particular we want to set microbial indicators of optimal performance and warning indicators of process failure.

Required background of the student: (Which should be the main field of study of the applicant before applying)
Analytical chemistry or microbial ecology/molecular biology or experience in biotechnology and bioprocesses engineering. Good knowledge of bioinformatics and biostatistics will be considered positively as well as lab work experience.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. **Hao L, Bize A, Conteau D, Chapleur O, Courtois S, Kroff P, Desmond-Le Quéméner E, Bouchez T, Mazéas L.** 2016. New insights into the key microbial phylotypes of anaerobic sludge digesters under different operational conditions. Water Res **102:**158-169.

2. **Lü F, Bize A, Guillot A, Monnet V, Madigou C, Chapleur O, Mazéas L, He P, Bouchez T.** 2014. Metaproteomics of cellulose methanisation under thermophilic conditions reveals a surprisingly high proteolytic activity. ISME J **8:**88-102.
3. **Madigou C, Poirier S, Bureau C, Chapleur O.** 2016. Acclimation strategy to increase phenol tolerance of an anaerobic microbiota. Bioresour Technol **216:**77-86.
4. **Poirier S, Bize A, Bureau C, Bouchez T, Chapleur O.** 2016. Community shifts within anaerobic digestion microbiota facing phenol inhibition: Towards early warning microbial indicators? Water Res **100:**296-305.
5. **Poirier S, Desmond-Le Quéméner E, Madigou C, Bouchez T, Chapleur O.** 2016. Anaerobic digestion of biowaste under extreme ammonia concentration: Identification of key microbial phylotypes. Bioresour Technol **207:**92-101.

Research Topic for the ParisTech/CSC PhD Program

Field (**Biology, Biophysics and Bio Chemistry):**

Subfield: (Molecular Physiology)

Title: Neurotransmitter signaling pathways in tick salivary gland

ParisTech School: AgroParisTech

Advisor(s) Name: Ladislav Simo
Advisor(s) Email: ladislav.simo@vet-alfort.fr
(Lab, website): https://www.researchgate.net/profile/Ladislav_Simo

Short description of possible research topics for a PhD: In this research proposal we aim to study salivary gland (SG) neural control in the *Ixodes ricinus*, the most prominent tick vector of disease-causing viral, bacterial, and protozoan agents in Europe. The relationships between tick species and the pathogens they transmit are complex, as pathogens depend upon the tick's saliva for their transmission into the host. The signalling between synganglion (the tick central nervous system) and SGs is very complex, and holds vital clues to understanding key aspects of SG functionality. The neural controls regulating tick SGs are crucial in both on- and off-host stages and therefore characterizing their molecular elements along with G-protein coupled receptor (GPCR) transduction events is of particular importance, and has a strong potential to elucidate key aspects about parasitic tick lifestyles. Specific aim of this project is to explore the relationship between the tick's central nervous system and SGs. Such approach is expected to uncover the molecular nature of tick SG control, and uses highly innovative tools to investigate its impact on functioning of this tissue. The data obtained in this study are expected to provide potential targets to disturb and control the ectoparasitic lifestyle of multiple tick species worldwide.

Required background of the student: Experience in basic molecular biology and/or biochemistry techniques. This includes but is not limited: cDNA synthesis, qRT-PCR, molecular cloning, immunohistochemistry, heterologous expression. Familiarity with imaging and bioinformatique is preferable. The applicant has to have solid writing and speaking skills in English.

A list of 5(max.) representative publications of the group: (Related to the research topic)

Gulia-Nuss M., et al., (Ixodes scapularis genome sequencing consortium), Genomic insights into the Ixodes scapularis tick vector of Lyme disease. Nature Communications. 7:10507, doi:10.1038/ncomms10507, 2016

Šimo L., Koči J., Kim D. H., Park Y., Invertebrate specific D1-like dopamine receptor in control of salivary glands in the black-legged tick Ixodes scapularis, Journal of Comparative Neurology 522(9):2038-52, 2014

Šimo L., Koči J., Park Y., The receptors for neuropeptides myoinhibitory peptide and SIFamide in the salivary glands of the blacklegged tick, Ixodes scapularis, Insect Biochemistry and Molecular Biology 43:376-387, 2013

Šimo L., Koči J., Žitňan D. and Park Y., Evidence for D1 dopamine receptor activation by a paracrine signal of dopamine in tick salivary glands, PLoS ONE 6(1): e16158, 2011

Šimo L., Žitňan D. and Park Y., Two novel neuropeptides innervate the salivary glands in the blacklegged tick Ixodes scapularis: Myoinhibitory peptide and SIFamide, Journal of Comparative Neurology 517:551–563, 2009

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Life and Health Science and Technology, Life Science and Engineering for Agriculture, Food and the Environment
Subfield: Life Science, OneHealth
ParisTech School: AgroParisTech

Title: Genetic variability of tick-borne viruses

Advisor(s): (name, email, website)
Sara Moutailler, sara.moutailler@anses.fr
https://www.researchgate.net/profile/Sara_Moutailler
https://www6.inra.fr/bipar_eng/WHO-ARE-WE/Teams/VECTOTIQ/The-Team/

Short description of possible research topics for a PhD:
Most arthropod-borne viruses (arboviruses) are RNA viruses, which are maintained in nature by replication cycles that alternate between arthropod and vertebrate hosts. Arboviruses appear to experience lower rates of evolution than RNA viruses that replicate only in a single host. This genetic stability is assumed to result from a fitness trade-off imposed by host alternation, which constrains arbovirus genome evolution. To test this hypothesis for tick-borne viruses, we will use 6 different viruses (from different viral families) that will be (1) maintain continuously in tick cell lines or mammalian cell lines and alternatively between tick and mammalian cell lines, (2) maintain continuously in ticks (*Ixodes ricinus* by artificial infection) and mice or alternatively between ticks and mice, (3) sequenced using high throughput sequencing (whole genome sequencing). Then genetic variability of those viral populations obtained in these different conditions will be assessed to identify viral compulsory genes implicated in tick and/or mammalian transmission. These data might give the opportunity to discover new antiviral strategies in tick vector and mammalian host, and will help to better predict arbovirus emergence and crossing species barriers.

Required background of the student:
We expect a highly motivated student with experience in virology and cell culture and/or molecular biology. Working Experience with arthropods and/or animal models will be highly appreciated. Good command of English and/or French is crucial.

A list of 5 (max.) representative publications of the group: (Related to the research topic)
- **Moutailler S** et al 2016. Co-infection of ticks: the rule rather than the exception. Plos Neglected Tropical Diseases. 2016 Mar 17;10(3):e0004539. doi:0.1371/journal.pntd.0004539.
- **Moutailler S**, et al 2016. Diversity of viruses in Ixodes ricinus and characterization of a neurotropic strain of Eyach virus. New microbes and new infections, 2016 Mar 5;11:71-81. doi: 10.1016/j.nmni.2016.02.012
- Michelet L, Delannoy S, Devillers E, Umhang G, Aspan A, Juremalm M, Chirico J, van der Wal FJ, Sprong H, Boye Pihl TP, Klitgaard K, Bodker R, Fach P, **Moutailler S**. 2014. High-throughput screening of tick-borne pathogens in europe. Frontiers in Cellular and Infection Microbiology, 4:103. doi: 10.3389/fcimb.2014.00103.
- Arias-Goeta C, **Moutailler S**, et al 2014. Chikungunya virus adaptation to a mosquito vector correlates with only few point mutations in the viral envelope glycoprotein. Infection, Genetics and Evolution 24:116-26. doi: 10.1016/j.meegid.2014.03.015.
- **Moutailler S**, et al. 2011. Host alternation is necessary to maintain the genome stability of Rift Valley Fever Virus. PLoS Negl Trop Dis 5(5):e1156. doi: 10.1371/journal.pntd.0001156.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Life and Health Science and Technology, Life Science and Engineering for Agriculture, Food and the Environment
Subfield: Life Science, OneHealth
ParisTech School: AgroParisTech

Title: Could tick symbionts interfere with tick-borne pathogen transmission?

Advisor(s): (name, email, website)
Sara Moutailler, sara.moutailler@anses.fr ; https://www.researchgate.net/profile/Sara_Moutailler
Thomas Pollet, thomas.pollet@vet-alfort.fr ;
https://www.researchgate.net/profile/Thomas_Pollet
https://www6.inra.fr/bipar_eng/WHO-ARE-WE/Teams/VECTOTIQ/The-Team

Short description of possible research topics for a PhD:
Interactions between arthropods and their microbiota could interfere with vector-borne pathogen transmission. Recent studies have indeed shown that virus infection and transmission (e.g. Dengue and Chikungunya) in mosquitoes can be impeded by co-infection with the bacteria *Wolbachia*. In ticks, until recent years, few information was available regarding their microbiota and symbionts that could be implicated in tick-borne pathogen transmission. Recent works using high throughput sequencing approaches gave the opportunities to discover symbionts that could be implicated in the transmission of tick-borne pathogens. In our team, we successfully use the 16S rRNA gene sequencing to identify tick microbiota and their interaction with tick-borne pathogens. Different species of symbionts will be test *in vivo* for their possible implication in the transmission of tick-borne pathogens by *I. ricinus* with a specific interest in the transmission of *Borrelia* species (for Lyme group) and Tick-borne encephalitis virus as models. These data on *I. ricinus* pathogens and symbionts might be a first step towards developing successful control strategies by manipulating tick microbiomes and helping to control tick-borne diseases such as Lyme disease.

Required background of the student:
We expect a highly motivated student with experience in entomology (ticks mainly), microbiology and/or cell culture and/or molecular biology. Experience working with animal models and/or virus will be highly appreciated. Good command of English and/or French is crucial.

A list of 5 (max.) representative publications of the group: (Related to the research topic)
- Cabezas-Cruz et al. 2018. Handling the microbial complexity associated to ticks. Book Chapter IntechOpen Ticks and Tick-borne Pathogens Chapter. In press.
- Raileanu et al. 2017. Borrelia diversity and Co-infection with Other Tick Borne Pathogens in Ticks. Front. Cell. Infect. Microbiol. 7:36. doi: 10.3389/fcimb.2017.00036.
- Michelet et al. 2016. Tick species, tick-borne pathogens and symbionts in an insular environment off the coast of Western France. Ticks and Tick-Borne Diseases, 2016. Aug 29. pii: S1877-959X(16)30138-8. doi: 10.1016/j.ttbdis.2016.08.014.
- Moutailler et al. 2016. Co-infection of ticks: the rule rather than the exception. Plos Neglected Tropical Diseases. 2016 Mar 17;10(3):e0004539. doi: 10.1371/journal.pntd.0004539.
- Michelet et al 2014. High-throughput screening of tick-borne pathogens in europe. Frontiers in Cellular and Infection Microbiology, 4:103. doi: 10.3389/fcimb.2014.00103.

Research Topic for the ParisTech/CSC PhD Program

***Field:* Economics, management and social sciences / Urban planning and Transport**

Subfield: Sociology, Political Science, Geography, or Urban planning
Title:**Agricultural activities in land use planning and food planningpolicies**
ParisTech School: AgroParisTech
Advisor(s) Name: Romain MELOT, researcher in sociology, INRA Sadapt/AgroParisTech (co-advisor : Frédéric WALLET, researcher in economics and regional science,INRA Sadapt/AgroParisTech)
Advisor(s) Email:romain.melot@agroparistech.fr
(Lab, website):https://www6.versailles-grignon.inra.fr/sadapt

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

The land use policy instruments typically deployed to support local agriculture are characterized by a tension between two objectives: preserving farmland and containing urban growth. Taking agricultural activity into account in planning documents is an issue that has been raised by research on periurban land use planning, since planning tools have historically been designed primarily to organize urbanization rather than to preserve agricultural land resources.
Besides the traditional role of land use planning, local governments in France has recently fostered the implementation of food planning policies which propose innovative strategies to support sustainable food procurement systems. "Local food plans"elaborate territorial projects to maintain and promote agricultural activities connected to cities and contribute to the political design of the rural-urban link. Combining sustainable land use, re-territorialization of agriculture and food autonomy is at stake in most of local authorities' strategies.
The PhD research project will be dedicated to a comprehensive understanding of local planning tools dedicated to agricultural development, by comparing the place of agricultural activities in both land use planning and food planning instruments in a sample of case studies in France highlighting situation and differences between mid-size cities and metropolitan areas. The research will propose avenues of improvement for territorial development policies dealing with periurban agriculture, in a perspective of providing valuable results for cities of foreign countries.

Required background of the student: The applicant should have worked on the issue of regional development or planning policies in sociology, geography, political science or urban planning.

A list of 5(max.) representative publications of the group: (Related to the research topic)

Melot R. (2016). How to Regulate the Peri-urban Town. Local Political Decisions and Styles of Justification, French Sociological Review 57-4, 2016, 501–521

Melot, R., Paoli, J.-C. (2016). Testing the waters of coastal urbanization: contested projects on protected lands. European Planning Studies, 24 (11), 1959-1977.DOI: 10.1080/09654313.2016.1219698

Melot R. (2018) Pre-emption rights in France: disputes over pre-emptions and the 'land scarcity', In Ger ber J.-D. (ed.), Hartmann T. (ed.), Hengstermann A. (ed.) Instruments of Land Policy. Dealing with Scarcity of Land. New York, USA : Routledge. 370 p.

Torre, A., **Wallet**, F. (2015). Towards New Paths for Regional and Territorial Development in Rural Areas. European Planning Studies, 23 (4), 650 - 677. , DOI : 10.1080/09654313.2014.945812

Wallet, F., Torre, A. (2014). Regional development and proximity relations. New Horizons in Regional Science. Londres, INT : Edward Elgar Publishing, 392 p., DOI : 10.4337/9781781002896

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Design, Industrialization, Life Science and Engineering for Agriculture, Food and the Environment

Subfield: (Biorefinery design, food technology, engineering and process optimisation)

Title:**Valorization of Insects and larvae into high-value functional proteins: eco-design, modelling and energy assessment**

ParisTech School:

Doctoral School ABIES (Agriculture Food Biology Environment Health)

Advisor(s) Name:

Samir MEZDOUR and Hedi ROMDHANA (AgroParisTech, Paris Institute of technology for life, food and environmental sciences)

Advisor(s) Email:

samir.mezdour@agroparistech.fr

hedi.romdhana@agroparistech.fr

(Lab, website):Researcher in Joint Research Center JRU1145 Food Process Engineering (France)

Short description of possible research topics for a PhD:

Problem statement: Self-sufficiency and food security is a major issue that requires exploring new nutritional resources. Insects and larvae are sources of protein and lipid and would be the ideal, nutritious and ecological food. The production of food grade functional proteins and other high-value ingredients requires the development of insect extraction and purification processes.

Objectives of the PhD thesis: The overall objective of this research is to conduct a detailed expertise of insect fractionation process by considering technical feasibility and energy performance. Given the range of by-products that can be separated from insects, this project aims to extend the scope of the study towards an insect biorefinery design.Thanks to a thermomechanical fractionation it is possible to obtain a delipidated protein meal. This product must be dried in order to be stored safely and then used as an ingredient or additive for animal feed. In addition, the isolated lipids can be recovered as liquid-fuel to produce a heating utility (steam or hot water). Lipids can also undergo an esterification transformation to be upgraded to biofuel potentially used in cogeneration process.The specific tasks are: (a)conduct air- and SHS- drying experiments by using a lab-scale dryer and find out the effect of various process parameters on the drying kinetics and the product quality. (b) Develop a mathematical model, to predict the temperature and the moisture profiles of the drying product. (C) investigate the energy efficiency by combining drying technology using SHS and air at low temperature, and to determine operating conditions that maximize the net energy gains while satisfying constraints on the product quality. (D) Perform an energy assessment to evaluate the possibility of producing a biofuel from the lipid fraction and ensure an energy self-sufficient for the insect biorefinery.

Required background of the student: (food technology, biotechnologies)

A list of 5(max.) representative publications of the group: (Related to the research topic)

Maillard F., Macombe C., Aubin J., **Romdhana H., Mezdour S.** (2018) Mealworm Larvae Production Systems : Management Scenarios, in Edible Insects in Sustainable Food Systems pp 277-301

Romdhana H., Goujot D. (2018)towards a simple, generic and rapid simulation of the drying of solid foods, LDRT2018-0302.R2 (accepted in drying technology)

Lambert C., Laulan B., Decloux M., **Romdhana H**. (2018) Simulation of a sugar beet factory using a chemical engineering software (ProSimPlus®) to perform Pinch and exergy analysis. Journal of food ing, 225, 1-11.

Chriyat Y., **Romdhana H.** (2018) A concept and industrial testing of a superheated steam rotary dryer demonstrator: Cocurrent-triple pass design, Drying tech,1-7.

Azagoh, C., Hubert, A., &**Mezdour, S.**(2015). Insect Biorefinery in Europe "DESigning the Insect bioRefinery to contribute to a more sustainable agro-food industry". Journal of Insectsas Food and Feed, 1(2), 159-168.

Azagoh, C., Ducept, F., Garcia, R., Rakotozafy, L., Cuvelier, M.-E., Keller, S., Lewandowski, R., &**Mezdour, S. (**2016). Extraction and physicochemical characterization of Tenebrio molitorproteins. Food Research International, Volume 88, Part A, October 2016, Pages 24-3.

Research Topic for the ParisTech/CSC PhD Program

Fields: Environment Science and Technology, Sustainable Development, Geosciences; Chemistry, Physical Chemistry and Chemical Engineering; Energy, Processes; Materials Science, Mechanics, Fluids.

Subfield: Experimental Fluid Mechanics in Porous Media.

Title:Experimental investigation of yield stress fluids flow in porous media with application to the development of a new porosimetry method.

ParisTech School:Ecole Nationale Supérieure d'Arts et Métiers.

Advisor(s) Name:

Pr. Azita AHMADI-SÉNICHAULT
Dr. Antonio RODRÍGUEZ DE CASTRO
Pr. Abdelaziz OMARI

Advisor(s) Email:

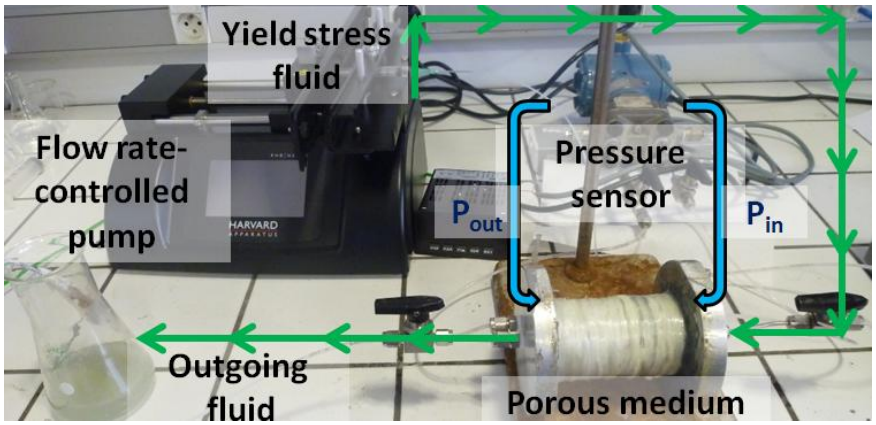
azita.ahmadi-senichault@u-bordeaux.fr
antonio.rodriguezdecastro@ensam.eu
abdelaziz.Omari@enscbp.fr

Lab, website:

Institut de Mécanique et d'Ingénierie de Bordeaux (I2M)
https://www.i2m.u-bordeaux.fr/Recherche/TREFLE-Transfert-Fluide-Energetique

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

The Yield Stress fluids porosimetry Method (YSM) to characterize Pore Size Distribution (PSD) of porous media was recently presented as a potential alternative to toxic Mercury Intrusion Porosimetry (MIP). It consists in measuring the flow rate Q at several pressure gradients ∇P during flow experiments of yield stress fluids through porous media. PSD is essential in many industrial processes such as Enhanced Oil Recovery (EOR) or soil remediation. The objective of this PhD thesis is to improve YSM method in order to meet the industrial standards of robustness, accuracy and reliability. To do so, laboratory flow experiments will be conducted on a set of porous media with increasing complexity: 1) microfluidic chips with cylindrical patterns, 2) model granular media formed by packs of spherical glass beads with monomodal or bimodal particle sizes, 3) packs of glass beads with markedly different particle sizes and 4) real or reconstructed heterogeneous 3D porous media. The obtained PSDs will then be compared to those provided by well-established porosimetry techniques. In parallel to laboratory experiments, the method used to extract PSD from the $(Q, \nabla P)$ measurements will be improved on the basis of pore-network modelling approaches by considering variable cross-section and connectivity of the pores.



Basic experimental setup

Required background of the student: A solid theoretical and experimental understanding of the fundamentals of fluid mechanics is required. The principles of mathematical programming and numerical methodsmust be known.Performing experiments requires dexterity, autonomy and meticulousness.

A list of 5(max.) representative publications of the group: (Related to the research topic)

- Rodríguez de Castro, A., Ahmadi-Sénichault, A., Omari, A., Using Xanthan Gum Solutions to Characterize Porous Media with the Yield Stress Fluid Porosimetry Method: Robustness of the Method and Effects of Polymer Concentration, Transport in Porous Media 122(2), 357 – 374 (2018).
  http://doi.org/10.1007/s11242-018-1011-8
- Rodríguez de Castro, A., Ahmadi-Sénichault, A., Omari, A., Savin, S., Madariaga, L.-F., Characterizing porous media with the Yield Stress Fluids porosimetry Method, Transport in Porous Media 114, 213-233 (2016).
  http://dx.doi.org/10.1007/s11242-016-0734-7
- Rodríguez de Castro, A., Omari, A., Ahmadi-Sénichault, A., Bruneau, D., Toward a New method of Porosimetry: Principles and Experiments, Transport in Porous Media, 101, 349-364 (2014).
  http://dx.doi.org/10.1007/s11242-013-0248-5

Research Topic for the ParisTech/CSC PhD Program

Field : Materials Science, Mechanics, Fluids
Subfield : Fluid mechanics, applied mathematics, process engineering.
Title: Tackling a scientific challenge impacting 21st century technologies : heat transfer coefficients in porous materials.
ParisTech School: Arts et Métiers ParisTech.
Advisor(s) Name: Azita Ahmadi, Jean Lachaud
Advisor(s) Email: ***azita.ahmadi-senichault@u-bordeaux.fr*** **,** ***jean.lachaud@u-bordeaux.fr***
Lab, website : *https://www.i2m.u-bordeaux.fr/*

Short description of possible research topics for a PhD:
Numerous technologies in development rely on porous materials : heat exchangers for solar concentrators, biofuel production processes, new generation energy storage as fuel cells and supercapacitors, space vehicle heat shields, etc. Chemical engineers and researchers at the forefront of their own fields and leading 21st century innovation would greatly benefit from fundamental developments in heat and mass transfer to reinforce application-specific phenomenological models. The contribution of this PhD project will be to develop a generic numerical framework to assess and model heat exchanges between the solid structure of a porous material and fluid flowing through the network of pores.
The study will fall into 3 interrelated tasks relying on a multi-scale approach. (1) Idealized and realistic microscopic material architectures will be produced by 3D printing. Experimentally, a cold gas will be flown through hot porous structures and the gas temperature evolutions will be measured. (2) Direct numerical simulations will be carried out at the microscopic scale to analyze and model heat exchanges between solid and fluid phases. (3) High order homogenization techniques will be used to develop macroscopic scale two temperature models. Effective heat exchange coefficients models will be developed based on experimental and numerical analyses on a wide range of Reynolds and Péclet numbers.
Finally, a verified numerical simulation tool implementing the microscopic and macroscopic models will be made available to impact the 21st century industrial challenges. The simulation tool will allow computing heat exchanges within the pores from three-dimensional tomography images. This advanced capability will be integrated in the Porous material Analysis Toolbox based on OpenFoam (PATO) released open source by NASA (https://software.nasa.gov/software/ARC-16680-1A).

Required background of the student: mechanical engineering, numerical simulation.

A list of 5 representative publications of the group
Ucar, E., Mobedi, M. & Ahmadi, A., Interfacial convective heat transfer for randomly generated porous media, Heat Transfer Research 49 (1) :1–14 (2018).
J. B. E. Meurisse, J. Lachaud, F. Panerai, C. Tang, N. N. Mansour. Multidimensional material response simulations of a full-scale tiled ablative heatshield. Aerospace Science and Technology. 76 : 497–511, 2018.
J. Lachaud, J. B. Scoggins, T. E. Magin, M. G. Meyer, N. N. Mansour. A generic local thermal equilibrium model for porous reactive materials submitted to high temperatures. International Journal of Heat and Mass Transfer. 108 : 1406-1417, 2017.
J. Lachaud, N. N. Mansour. Porous material analysis toolbox based on OpenFoam and applications. Journal of Thermophysics and Heat Transfer, 28 (2): 191-202, 2014.
Lux, J, Ahmadi, A., Gobbé, C., Delisée, C., Macroscopic thermal properties of real fibrous materials: Volume averaging method and 3D image analysis, International Journal of Heat and Mass Transfer, 49 : 1958-1973, 2006.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field:Materials Science, Mechanics, Fluids

Subfield: Mech. Eng.

Title: A strategy to build reduced mechanical models of composites structures based on data and machine learning

ParisTech School: Arts et Métiers (Campus of Bordeaux)

Advisor(s)Ivan Iordanoff, Pulière Etienne, Frédéric Dau
Advisor(s) Email:etienne.pruliere@ensam.eu, frederic.dau@ensam.eu
(Lab, website):I2M (https://www.i2m.u-bordeaux.fr/)

Short description of possible research topics for a PhD:

A change of paradigm is being observed in most of industrial sectors with the constant increase of available data and the massive use ofartificial intelligence. In mechanical engineering, a reliable and rich phenomenological/experimental database can be sometimes more efficient than models based on physics.

In the domain of designing composite structures, the complexity of existing models can be damningdue to the high number of parameters to identify consideringthe multi-scale, multiple failure modes, coupling and natural variability aspects.There is therefore a great challenge in combining a good knowledge of the physics and available data to get a quick assessment of the behavior of a structure and the risk of failure,including variability.

The aim of this project is to explore new approaches based on model reduction, data analysis techniques and machine learning in order to build hybridmodels (based on physics and data) on the fly and to reduce considerably the complexity of designing process.

Required background of the student:
Mechanical engineering, numerical methods, programming, composites materials

A list of 5(max.) representative publications of the group: (Related to the research topic)

S. Metoui, E. Pulière, A. Ammar, F. Dau, I. Iordanoff, The proper generalized decomposition for the simulation of delamination using cohesive zone model, à paraître dans *International Journal for Numerical Methods in Engineering*, 99:13 (2014), pp 1000–1022

S. Metoui, E. Pruliere, A. Ammar, F. Dau, I. Iordanoff, A multiscale separated representation to compute the mechanical behavior of composites with periodic microstructure, Mathematics and Computers in Simulation, In Press (published online)

E. Pulière, F. Chinesta, A. Ammar, On the deterministic solution of multidimensional parametric models using the Proper Generalized Decomposition, *Mathematics and Computers in Simulation*, 81:4 (2010), pp 791-810

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)
Mechanical Engineering

ParisTech School: Arts et Metiers ParisTech

Title: Very-high-cycle fatigue strength of metals under multiaxial stress state

Advisor(s): (name, email, website)
Prof. Thierry PALIN-LUC, (Arts et Metiers ParisTech, Institute of Mechanics and Mechanical Engineering)
email: thierry.palin-luc@ensam.eu, web: http://i2m.u-bordeaux.fr
and https://www.researchgate.net/profile/Thierry_Palin-Luc/publications

Prof. Youshi HONG (Institute of mechanics, Chinese academy of sciences)
email: hongys@imech.ac.cn
web:.http://sourcedb.imech.cas.cn/zw/rck0/zgjzj/fxxlx/201211/t20121129_3694914.html

Prof. Guian Qian (Institute of mechanics, Chinese academy of sciences)
email: qianguian@imech.ac.cn, web:. https://www.researchgate.net/profile/Guian_Qian/publications
and https://scholar.google.com/citations?user=Cgr7R_kAAAAJ&hl=en

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
The design of safe components capable to endure a very high number of loading cycles: 10^9 cycles and more, is a very important challenge for engineers. If the fatigue strength of components can now be simulated up to 10^7 cycles under complex loadings that are representative of real multiaxial loadings and stress states, this is not the case in the gigacycle regime (10^9 cycles and more). Indeed, since the end of the last century it is known that there is no infinite fatigue life of metals. The crack initiation mechanisms are more and more understood under uniaxial loadings (tension, bending) and a few models only have been published to assess the fatigue strength of metals under such loadings in the gigacycle regime. But there is nothing published under multiaxial loadings that are representative of real load cases of components.
A few ultrasonic fatigue testing machine have been recently developed in our team to test metallic specimens under torsion or under biaxial bending. A quite comprehensive study on very-high-cycle fatigue of different materials has also been performed in our team. The aim of this PhD is to study the gigacycle fatigue strength of two metallic alloys (an aluminum one and a steel) under uniaxial (tension) and multiaxial (torsion and biaxial bending). The crack initiation and early crack growth mechanisms will be studied to propose a fatigue criterion capable to compute the very-high-cycle fatigue strength under multiaxial loadings.

Required background of the student: (Which should be the main field of study of the applicant before applying)
Solid mechanics, Mechanical engineering, Material science, Material physics

A list of 5 (max.) representative publications of the group: (Related to the research topic)
[1] A. Nikitin, T. Palin-Luc, A. Shanyavskiy (2016) Crack initiation in VHCF regime on forged titanium alloy under tensile and torsion loading modes, International Journal of Fatigue, Vol. 93, pp. 318–325.
[2] C. Brugger, T. Palin-Luc, P. Osmond and M. Blanc (2017) A new ultrasonic fatigue testing device for biaxial bending in the gigacycle regime, Internation Journal of Fatigue, vol. 100, pp. 619 – 626.
[4] A. Banvillet, T. Palin-Luc and S. Lasserre (2003) A volumetric energy based high cycle multiaxial fatigue criterion. Int. Journal of Fatigue, Vol. 25, pp. 755-769.
[5] G. Qian, C. Zhou and Y. Hong (2015) A model to predict S–N curves for surface and subsurface crack initiations in different environmental media, Int. J. Fatigue, Vol. 71, pp. 35-44.
[6] G. Qian, C. Zhou and Y. Hong (2011) Experimental and theoretical investigation of environmental media on very-high-cycle fatigue behavior for a structural steel, Acta Materialia, Vol. 59, pp. 1321-1327.

Research Topic for the ParisTech/CSC PhD Program

(one page maximum)

****Field (cf. List of fields below): 8***

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)
Processes,Mechanics,Materials Science

Title:Enhanced Surface integrity of Ti-6Al-4V parts produced by SLM and Machining: Multiphysics approach and Virtual Simulations

ParisTechSchool: Sciences des Métiers de l'Ingénieur(SMI)

Advisor(s) Name: J. C. Outeiro, LaBoMaP, Arts et MetiersParisTech, Campus of Cluny.
A. Moufki, LEM3, University of Lorraine, Metz.
Advisor(s) Email:jose.outeiro@ensam.eu abdelhadi.moufki@univ-lorraine.fr
(Lab, website):http://labomap.ensam.eu/http://www.lem3.univ-lorraine.fr/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

3D printing, also referred to Rapid Prototyping (RP), is a manufacturing process to directly generate physical objects with defined structure and shape from a virtual 3D model data. One of the most promising technique is Selective Laser Melting (SLM). The SLM process is based on a high energy laser that melts the powder particles. In the aerospace industry, SLM is used to produce functional prototypes and small series of Titanium alloys parts with high mechanical properties and high geometrical complexity. Additionally, to obtain a functional product with dimensional and structural requirement of industrial parts, the components produced by SLM requires a machining step. Due to their material properties (high mechanical tensile strength retained at high temperature; low modulus of elasticity; low thermal conductivity; high chemical reactivity), titanium alloy Ti-6Al-4V is classified as a difficult-to-machine material. Besides, during SLM process, the rapid cooling of the material leads to thermally induced residual stresses. Thus, initial state of SLM-produced can affect the machining operation and have a significant influence on the functional performance and life of components. Surface integrity of machined workpiece plays a critical role in the mechanical characteristics of machined components such as fatigue life and corrosion resistance. Therefore, the relationship between the effects of the manufacturing processes SLM-Machining and the surface integrity has to be investigated deeply for titanium alloy Ti-6Al-4V. In this work, surface integrity will be investigated using both modeling and experimental approaches. The purpose of the modeling part is to perform Multiphysics Simulations in order to understand the interactions between several physical phenomena.

Required background of the student: (Which should be the main field of study of the applicant before applying)

The candidate should have a knowledge of the finite element (FE) method, MATLAB programming language and continuum mechanics.

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] I.S. Jawahir, E. Brinksmeier, R. M'Saoubi, D.K. Aspinwall, J.C. Outeiro, D. Meyer, D. Umbrello, A.D. Jayal, "Surface Integrity in Material Removal Processes: Recent Advances", *CIRP Annals - Manufacturing Technology*, keynote paper, 60 (2), 2011, 603-626.

[2] K.S.Djaka, A.Moufki, M.Nouari, P.Laheurte, A.Tidu. A semi-analytical modelling of cutting using crystal plasticity theory and flow line approach. *Int. J. of Mechanical Sciences*, 146-147, 2018, 49-59.

[3] A. Moufki, D. Dudzinski, G. Le Coz, Prediction of cutting forces from an analytical model of oblique cutting, application to peripheral milling of Ti-6Al-4V alloy, *International Journal of Advanced Manufacturing Technology*, 81 (1-4), 2015, 615-626.

[4] L.A. Denguir, J.C. Outeiro, G. Fromentin, V. Vignal, R. Besnard, A physical-based constitutive model for surface integrity prediction in machining of OFHC copper, Journal of Materials Processing Technology, Vol. 248, pp. 143–160, 2017

[5] Z. Pu, G.-L. Song, S. Yang, J.C. Outeiro, O.W. Dillon Jr., D.A. Puleo, I.S. Jawahir, "Grain Refined and Basal Textured Surface Produced by Burnishing for Improved Corrosion Performance of AZ31B Mg Alloy", Corrosion Science, Vol. 57, pp. 192-201, 2012 (ISSN 0010-938X; I.F. 5.245).

Research Topic for the ParisTech/CSC PhD Program

(one page maximum)

****Field (cf. List of fields below): 8***

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)
Processes,Mechanics,Materials Science

Title:Machining of Ti-6Al-4V parts produced by Selective Laser Melting (3D printing): Multiphysics approach and Virtual Simulations

ParisTechSchool: Sciences des Métiers de l'Ingénieur(SMI)

Advisor(s) Name: J. C. Outeiro, LaBoMaP, Arts et MetiersParisTech, Campus of Cluny.
A. Moufki, LEM3, University of Lorraine, Metz.
Advisor(s) Email:jose.outeiro@ensam.eu abdelhadi.moufki@univ-lorraine.fr
(Lab, website):http://labomap.ensam.eu/http://www.lem3.univ-lorraine.fr/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

3D printing, also referred to Rapid Prototyping (RP), is a manufacturing process to directly generate physical objects with defined structure and shape from a virtual 3D model data. One of the most promising technique is Selective Laser Melting (SLM). The SLM process is based on a high energy laser that melts the powder particles. In the aerospace industry, SLM is used to produce functional prototypes and small series of Titanium alloys parts with high mechanical properties and high geometrical complexity. Additionally, to obtain a functional product with dimensional and structural requirement of industrial parts, the components produced by SLM requires a machining step. Due to their material properties (high mechanical tensile strength retained at high temperature; low modulus of elasticity; low thermal conductivity; high chemical reactivity), titanium alloy Ti-6Al-4V is classified as a difficult-to-machine material. Besides, during SLM process, the rapid cooling of the material leads to thermally induced residual stresses. Thus, initial state of SLM-produced can affect the machining operation and have a significant influence on the functional performance and life of components. Surface integrity of machined workpiece plays a critical role in the mechanical characteristics of machined components such as fatigue life and corrosion resistance. Therefore, the relationship between the effects of the manufacturing processes SLM-Machining and the surface integrity has to be investigated deeply for titanium alloy Ti-6Al-4V. In this work, surface integrity will be investigated using both modeling and experimental approaches. The purpose of the modeling part is to perform Multiphysics Simulations in order to understand the interactions between several physical phenomena.

Required background of the student: (Which should be the main field of study of the applicant before applying)

The candidate should have a knowledge of the finite element (FE) method, MATLAB programming language and continuum mechanics.

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] I.S. Jawahir, E. Brinksmeier, R. M'Saoubi, D.K. Aspinwall, J.C. Outeiro, D. Meyer, D. Umbrello, A.D. Jayal, "Surface Integrity in Material Removal Processes: Recent Advances", *CIRP Annals - Manufacturing Technology*, keynote paper, 60 (2), 2011, 603-626.

[2] K.S.Djaka, A.Moufki, M.Nouari, P.Laheurte, A.Tidu. A semi-analytical modelling of cutting using crystal plasticity theory and flow line approach. *Int. J. of Mechanical Sciences*, 146-147, 2018, 49-59.

[3] A. Moufki, D. Dudzinski, G. Le Coz, Prediction of cutting forces from an analytical model of oblique cutting, application to peripheral milling of Ti-6Al-4V alloy, *International Journal of Advanced Manufacturing Technology*, 81 (1-4), 2015, 615-626.

[4] L.A. Denguir, J.C. Outeiro, G. Fromentin, V. Vignal, R. Besnard, A physical-based constitutive model for surface integrity prediction in machining of OFHC copper, Journal of Materials Processing Technology, Vol. 248, pp. 143–160, 2017

[5] Z. Pu, G.-L. Song, S. Yang, J.C. Outeiro, O.W. Dillon Jr., D.A. Puleo, I.S. Jawahir, "Grain Refined and Basal Textured Surface Produced by Burnishing for Improved Corrosion Performance of AZ31B Mg Alloy", Corrosion Science, Vol. 57, pp. 192-201, 2012 (ISSN 0010-938X; I.F. 5.245).

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): 8 (Materials Science, Mechanics, Fluids)

Subfield: Mechanical Engineering, Wood Sciences, Signal Analysis

Title: Peeling process monitoring: online measurement of wood veneer quality by force, vibration and sound-wave signal analysis

ParisTech School: Arts et Métiers ParisTech

Advisor(s):

Supervising Professor: Pr Philippe Lorong, philippe.lorong@ensam.eu, Arts et Métiers ParisTech, Campus of Paris, PIMM (http://pimm.ensam.eu)
Thesis advisors: Louis Denaud, louis.denaud@ensam.eu and Stephane Girardon stephane.girardon@ensam.eu , Arts et Métiers, Campus of Cluny, LaBoMaP, http://labomap.ensam.eu/

Short description of possible research topics for a PhD:

Wood peeling process is largely used for plywood, LVL (Laminated Veneer Lumber) and light packaging production. This competitive business require a complete control of the process. Since wood is a heterogeneous material coming from the living, this objective is challenging and online feedback is required.

Experienced operators are able to detect problems during the peeling process by identifying characteristics sound or vibrations coming from the process. They can adapt lathe's settings to optimize veneer quality mainly described by lathe checks occurrence, veneer thickness variation and veneer surface roughness.

Some preliminary work performed on a laboratory scale have shown the possibility of detecting defects occurrence by vibrational and acoustical analysis [2], [3], [4]. The main objective of this PhD is to develop solutions for industrial applications which could be computed by signal analysis (time, spectral, time/frequency, cepstral…).

The LaBoMaP is currently the only laboratory equipped with an instrumented industrial peeling line (fig. 1) which contained: soaking pool, debarker, peeling lathe equipped with force gauges, laser veneer thickness and surface roughness measuring system, vibration and sound wave measuring system. Moreover, a specific apparatus was developed to fully characterize lathe checks [4] and will be used to verify the reliability of developed solutions. The management of the PhD will be insured by a collaboration between the PIMM and LaBoMaP.

Figure 1 : LaBoMaP Instrumented peeling line

Required background of the student:

Mechanical engineering, acoustic, mechanical vibration, signal analysis, (Wood material and products could be a plus)

Representative publications of the group: (Related to the research topic)

[1] Denaud L., Boukeri A., Krebs M., Butaud J.-C., and Letourneau R. (2015). *Online measurement of veneer lathe checks*. Presented at the 22nd International Wood Machining Seminar, Quebec City, Canada. ISBN: 978-0-9947964-0-0

[2] Denaud L. E., Bleron L., Eyma F., and Marchal R. (2012). *Wood peeling process monitoring: A comparison of signal processing methods to estimate veneer average lathe check frequency*. *European Journal of Wood and Wood Products*, *70*(1-3), 256–261.

[3] Denaud L. E., Bleron L., Ratle A., and Marchal R. (2007). *Online control of wood peeling process: Acoustical and vibratory measurements of lathe checks frequency*. *Annals of Forest Science*, *64*(5), 569–575.
[4] Palubicki B., Marchal R., Butaud J.-C., Denaud L. E., Bleron L., Collet R., and Kowaluk G. (2010). *A Method of Lathe Checks Measurement; SMOF device and its software*. *European Journal of Wood and Wood Products*, *10*, 151.

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

Subfield: MechanicalEngineering

Title: Experimental full-field strain and temperature measurement under extreme conditionsusing digital image correlation and an IR camera.Application to the machining process of titanium alloys.
ParisTech School: ENSAM (Angers).

Advisor(s):Idriss TIBA (idriss.tiba@ensam.eu), Guénaël GERMAIN(guenael.germain@ensam.eu)

Lab.: Laboratoire Angevin de Mécanique, Procédés et innovation (LAMPA, http://lampa.ensam.eu)

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
Improving our understanding of the thermal and mechanical phenomena involved during material deformation under extreme conditions is a major scientific challenge, especially for the study of manufacturing processes. This knowledgeleads to better modeling of what is a highly nonlinear problem and, consequently, increases the quality of numerical simulations. The latter provides predictions of the strain and temperature fields in order to improve the cutting parameters (cutting speed and cutting angles, tool shape, etc.). However, most of the experiments can only measure global or average values.
The objective of this PhD work is to develop an experimental protocolto measurethe fullstrain and temperature fieldsunder thermomechanical conditions representative of machining operations (pure shear deformation and high strain rates). The measurement of the mechanical fields will be performed byDigital Image Correlationusing ahigh-speed camera (cf. figure 1) and the temperature evolution will be measured by IR cameras/thermocouples.Thereby, a specific instrumentation for the measurement of the coupled mechanical and thermal fields will be required in this work.

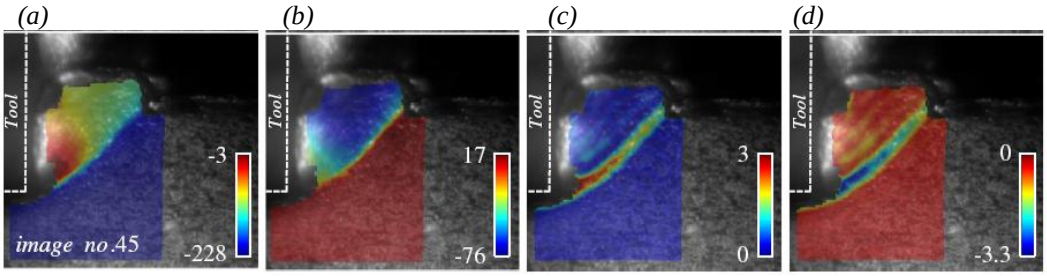


Figure 1 : (a) Horizontal displacement (in µ m). (b) Vertical displacement (in µ m). (c) Major strain. (d) Minor strain during the machining of the titanium alloys Ti64 (ap = 0.25 mm ;Vc = 6 m/min) [1]

Required background of the student: (Which should be the main field of study of the applicant before applying)
The student must have very good knowledge of continuous solid mechanics and instrumentation (optics).

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] T. Pottier, G. Germain, M. Calamaz, A. Morel, D. Coupard, 2014. Sub-Millimeter measurement of finite strains at cutting tool tip vicinity, Experimental Mechanics, Vol. 54, Is. 6, pp. 1031-1042.
[2] M. Harzallah, T. Pottier, R. Gilblas, Y. Landon, M. Mousseigne, J. Senatore, 2018.A coupled in-situ measurement of temperature and kinematic fields in Ti-6Al-4V serrated chip formation at micro-scale, International Journal of Machine Tools and Manufacture, 130–131, 20–35.
[3] M. Harzallah , T. Pottier, J. Senatore, M. Mousseigne, G. Germain, Y. Landon, 2017. Numerical andexperimentalinvestigations of Ti-6Al-4V chipgeneration and thermo-mechanicalcouplings in orthogonal cutting. International Journal of Mechanical Sciences 134, 189–202.
[4] C. Badulescu, M. Grédiac, H. Haddadi, J.-D. Mathias, X.Balandraud, H.-S.Tran, 2011.Applying the grid method and infrared thermography to investigate plastic deformation in aluminiummulticrystal, Mechanics of Materials, Vol. 43, Is. 1, pp. 36-53.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field (cf. List of fields below):
1. Materials Science, Mechanics, Fluids
2. Mathematics and their applications
3. Design, Industrialization

Subfield: Mech. Eng.

Title:Shaping the third millennium engineering: instantaneous numerical predictions, & data-driven engineering.

ParisTech School:ENSAM Angers

Advisor(s) Name: Amine AMMAR
Advisor(s) Email:Amine.AMMAR@ensam.eu
(Lab, website): LAMPA ***http://lampa.ensam.eu/***

Short description of possible research topics for a PhD:

Disruptive design needs exploring in almost real-time the whole design space, and even the space outside. The same constraint applies when addressing processes supervision and control, decision-making and in general any DDDAS (Dynamic Data Driven Application System) present in smart factories and FabLabs where a variety of twins (virtual, digital and hybrids), robots and augmented reality and intelligence coexists in a fully connected system (IoT). The key player: a cheap, fast, robust, adaptive and flexible numerical technique.

Model Order Reduction techniques aim at reducing the computing time without impacting the solution accuracy. Proper Generalized Decomposition, intensively considered and nowadays successfully coupled with virtual prototyping tools, allows for the construction of parametric solutions that integrate advanced artificial intelligence techniques for accomplishing unimaginable performances.

The present PhD position aims at conceiving new numerical tools for evaluating complex mechanical systems subjected to millions of loading cycles producing fatigue. Robust designs need for properly describing multi-scale loadings (where different characteristic times operates, from the one of the action (seconds) and the one of the component or system life (years). Then, that time multi-scale description should be adequately introduced into the modelling framework to anticipate general responses. Using these modelling different defaults can be synthetically produced for training neural networks for proceeding with predictive and operational maintenance by invoking standard or advanced artificial intelligence tools. Finally, gaps between predictions, assumptions (loading, assembling tolerances, …) and responses, will be integrated into a data-driven model able to ensure predictability performances.

Thus, systems could be monitored, inspected, controlledin service, all along their life in a radical new framework, by coupling models and data, all kind of “intelligence”.

Required background of the student:

- Engineering Mechanics (Continuum medium)
- Numerical Analysis
- Finite Element discretization

A list of 5(max.) representative publications of the group: (Related to the research topic)

- *Nasri, M.A., Robert, C., Ammar, A., El Arem, S., Morel, F. Proper Generalized Decomposition (PGD) for the numerical simulation of polycrystalline aggregates under cyclic loading. ComptesRendus - Mecanique, 346 (2) : 132-151, 2018. http://dx.doi.org/10.1016/j.crme.2017.11.009*
- *I. Alfaro, D. González, F Bordeu, A. Leygue, A. Ammar, E. Cueto, F. Chinesta. Real-time in silico experiments on gene regulatory networks and surgery simulation on handheld devices. Journal of Computational Surgery, 1:1, 2014. http://dx.doi.org/10.1186/2194-3990-1-1*
- *A. Ammar, A. Zghal, F. Morel, F. Chinesta. On the space-time separated representation of integral linear viscoelastic models. Comptes Rendus Mécanique, 343(4), 247–263, 2015. http://dx.doi.org/10.1016/j.crme.2015.02.002.*
- *C. Chancellor, A. Ammar, F. Chinesta, M. Magnin, O. Roux. Linking discrete and stochastic models: The chemical master equation as a bridge between process hitting and proper generalized decomposition. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 8130 LNBI, 50-63, 2013. http://dx.doi.org/10.1007/978-3-642-40708-6_5.*

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids.

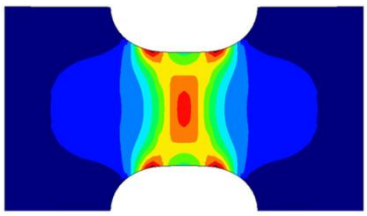
Subfield: **Mechanical Engineering**.

Title: Improving the characterization of a plasticity yield criterion using digital image correlation over enhanced heterogeneous tensile tests.

ParisTech School: Arts et Métiers – ParisTech (ENSAM)

Advisor(s): Halim HADDADI, halim.haddadi@ensam.eu; http://aa1.free.fr

Short description of possible research topics for a PhD:
To perform accurate numerical simulations of industrial process requiring plastic deformation of metals (e.g. forging, metal sheet forming), high parameter number constitutive laws of the mechanical behavior were developed. But their use in industry faces the complexity of the identification protocol of 10 to 200 parameters which requires a large number of standard mechanical tests.
This PhD project aims the development and the implementation of an identification procedure of the parameters of a plasticity yield criterion in the frame of large plastic deformation. This identification protocol will use a finite element model updating (FEMU) method based on both the total applied force–displacement curve and the full-field strain measurements obtained with a limited number of tensile tests performed with a non-standard sample which will be designed. This sample will have the merit of enhancing simultaneously: the heterogeneity of the strain fields and their sensitivity to the yield criterion. The stability of the identification algorithm will be tested on virtual tensile tests performed on the same sample type by adding perturbations to numerical simulation results. Finally, the protocol will be validated by performing tensile tests on another non-standard sample which was not included in the identification data.



Heterogeneous tensile test: longitudinal strain field [Haddadi and Belhabib, 2012]

Required background of the student:
- Mechanical engineering, Mechanical behavior of materials
- Finite element method and Matlab tools will be appreciated.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

- H. Haddadi, S. Belhabib, (2012), Improving the characterization of a hardening law using digital image correlation over an enhanced heterogeneous tensile test, International Journal of Mechanical Sciences, 62, 1, 47-56.
- H. Haddadi, S. Belhabib, (2008), Use of rigid-body motion for the investigation and estimation of the measurement errors related to digital image correlation technique, Optics and Lasers in Engineering, 46, 185-196.
- S. Belhabib, H. Haddadi, M. Gaspérini, P. Vacher, (2008), Heterogeneous tensile test on elastoplastic metallic sheets: Comparison between FEM simulations and full-field strain measurements, International Journal of Mechanical Sciences, 50, 14-21.
- H. Haddadi, S. Bouvier, M. Banu, C. Maier, C. Teodosiu, (2006), Towards an accurate description of the anisotropic behaviour of sheet metals under large plastic deformations: Modelling, numerical analysis and identification, International Journal of Plasticity, 22, 2226-2271.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below):
Materials Science, Mechanics, Fluids

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)
Mech. Eng.

Title:
Study of the infusion process for compositesusinga thermoplastic liquid resin

ParisTech School:
Ecole Nationale Supérieure d'Arts et Métiers

Advisor(s) Name: Laurent Guillaumat and Stephane Champmartin
Advisor(s) Email:laurent.guillaumat@ensam.eu, stephane.champmartin@ensam.eu
(Lab, website):LAMPA, http://lampa.ensam.eu/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
Preservation of natural resources forces the composite industry to search and examine eco-friendly components and processes. For that fibers coming from plants and recyclable resinsare more and more investigated. Thermoplastics are good candidates but their processes impose the use of an injection molding process restricting the size of the parts to be manufactured. Recently, a new thermoplastic liquid resin is proposed by Arkema but a lot of studies have to be done in order to optimize the manufacture of the parts with it.
This subject proposes:

1) To model the flow of this new liquid resin into a fabric with bio-fibers (analytical and numerical approaches);
2) To instrument the process in order to validate the previous simulations;
3) To optimize the process using the validated modellings;
4) To realize mechanical tests on samples manufactured by the optimized process to validate the quality of the material.

Required background of the student: (Which should be the main field of study of the applicant before applying)
The applicant should have a good background in non-Newtonian fluid mechanics, porous media and composite materials and should be interested in both numerical simulations and experimental techniques.
A list of 5(max.) representative publications of the group: (Related to the research topic)

- S. Champmartin, A. Ambari and J.Y. Le Pommelec. New procedure to measure simultaneously the surface tension and contact angle. Review of Scienti_c Instruments, 87: 055105, 2016.
- A. Oukhlef, S. Champmartin and A. Ambari. Yield stress _uids method to determine the pore size distribution of a porous medium. Journal of Non-Newtonian Fluid Mechanics, 204: 87-93, 2014.
- S. Champmartin, A. Ambari and R.J. Chhabra. Levitating spherical particle in a slightly tapered tube at low Reynolds numbers: Application to the low-flow rate rotameters. Review of Scientific Instruments, 83: 125103, 2012.
- A. Monti, A. El Mahi, Z.Jendli, L. Guillaumat, "Mechanical behaviour and damage mechanisms analysis of a flax-fibre reinforced composite by acoustic emission", Composites Part A: Applied Science and Manufacturing, volume 90, july 2016, pp 100-110.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below):
Materials Science, Mechanics, Fluids

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)
Mech. Eng.

Title:

Coupled fire and aging behaviours of bio-composites

ParisTechSchool:
Ecole Nationale Supérieure d'Arts et Métiers

Advisor(s) Name: Yan LIand Laurent GUILLAUMAT
Advisor(s) Email:liyan@tongji.edu.cn and laurent.guillaumat@ensam.eu,
(Lab, website):LAMPA, http://lampa.ensam.eu/ and Tongji University

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
The applications of natural fiber-based bio-composites in automotive components, building materials and aerospace industry are increasing, due to their ecological and economic advantages compared to synthetic composites.The main objective of this PhD study is to analyze the couple of fire and aging behaviors to, on the one hand, understand the different physical mechanisms and, on the other hand, propose solutions for the increasing of their performances.As also, realization of durability tests whether fatigue, impact or humid aging coupled by physico-chemical characterization and non-destructive and destructive controls of bio-composite materials.
The facility to realize exposure to fire has to be design.

The material should be a flax/polypropylene but we could imagine the testing of another one.

Required background of the student: (Which should be the main field of study of the applicant before applying)
The applicant should have a good background in materials and mechanics, and should be interested in both numerical simulations and experimental techniques.
A list of 5(max.) representative publications of the group: (Related to the research topic)

- A. Monti, A. El Mahi, Z. Jendli, L. Guillaumat, "Mechanical behaviour and damage mechanisms analysis of a flax-fibre reinforced composite by acoustic emission", Composites Part A: Applied Science and Manufacturing, volume 90, july 2016, pp 100-110.
- S.Liang, P.B.Gning, L.Guillaumat, "impact behaviour of flax/epoxy composite plates", international journal of impact engineering, volume 80, June 2015, Pages 56-64.
- S.Liang, P.B.Gning, L.Guillaumat, "A comparative study of fatigue behaviour of flax/epoxy and glass/epoxy composites.", Composites Science and Technology, Volume 72, Issue 5, pp 535-543, 2012.
- P.B.Gning, L.Guillaumat, S.Liang, PUI W.J."Influence of process and test parameters on the mechanical properties of flax/epoxy composites using response surface methodology.", Journal of Materials Science, Vol 46, Issue 21, Page 6801-6811, 2011.
- L.Guillaumat, F.Baudou, A.M.Gomes de Azevedo, J.L.Lataillade, "Contribution of the experimental designs for a probabilistic dimensioning of impacted composites.", International Journal of Impact Engineering, Vol. 31, Issue 6, pp 629-641, july 2005.

Research Topic for the ParisTech/CSC PhD Program

Field : Materials Science, Mechanics, Fluids

Subfield: Applied Physics, Mathematics,

Title: Crack modeling and detection in a rotating shaft: A standard approach

ParisTech School: Arts et MétiersParisTech

Advisor(s) Name: Saber EL AREM, Amine AMMAR
Advisor(s) Email: ***saber.elarem@ensam.eu*** ***amine.ammar@ensam.eu***
(Lab, website):

Short description of possible research topics for a PhD:
we have recently presented a generic methodology to deal with the mechanics of beams and shafts with cracks. By considering an appropriate expression of the system elastic energy, the procedure of identification of the crack breathing mechanism becomes simple and comprehensive. The 3D computations indispensable to the identification process are significantly reduced when the system energy properties are exploited. An adimensional function is identified giving a fine and precise description of the system flexibility evolution when the crack breathes. This breathing function is exclusively inherent to the crack geometry and completely independent of the model parameters. Hence, the approach is universal and could be applied straightforward to similar problems. Moreover, we gave an nonlinear fitting formula of the identified function that all the process of identification could be skipped when a cracked transverse section is to be inserted in a beam-like model of a cracked shaft. This standard and generic methodology is completed by a detailed description of the technique of construction of a cracked beam finite element (CBFE). A validation of the approach in quasistatic is given for a cantilever beam with one, then two cracked transverse sections.
This generic approach will be used to explore the nonlinear dynamics of a multi-cracked shaft and to develop a methodology for early crack detection based on the analysis of the vibrational behavior of the shaft.
Required background of the student: mechanics, physics, applied mathematics

A list of 5(max.) representative publications of the group:

[1] El Arem Saber, Maitournam Habibou "A cracked beam finite element for rotating shaft dynamics and stability analysis". Journal of Mechanics of Materials and Structures 2008;3(5):893–910.
[2] El Arem Saber "Shearing effects on the breathing mechanism of a cracked beam section in biaxial flexure". European Journal of Mechanics, A/Solids 2009;28:1079–87.
[3] El Arem Saber, Nguyen Quoc-Son. "Nonlinear dynamics of a rotating shaft with a breathing crack". Annals of Solid and Structural Mechanics 2012;3(1):1–14.
[4] EL Arem Saber, Ben Zid Maha. "On a systematic approach for cracked rotating shaft study: breathing mechanism, dynamics and instability". Nonlinear Dynamics 2017;88:2123–38.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Mechanical Eng. & Manufacturing Eng.

Title: Data driven manufacturing imperfections prediction – Digital twin for geometrical quality management

ParisTech School: Arts et Métiers ParisTech

Advisor(s) Name: Prof. Jean-Yves DANTAN
Advisor(s) Email:jean-yves.dantan@ensam.eu
(Lab, website):lcfc.ensam.fr

Short description of possible research topics for a PhD:
This aim of this proposal is the development of approaches and techniques to characterize the inherent imperfections of manufacturing processes and resources. Effective reuse of enterprise data about manufacturing processes is a key strategic component of the robust design, tolerance allocation … Process capability approach allows for an understanding of the capability of machines, tools, and operators to manufacture a particular feature of a particular dimension. With the data captured in digital twins, it is possible to evaluate the process capability in real time, and also to predict the realized shape with geometrical deviations (predictive modeling). The digital twins will allow the check for conformance of the product specifications with the design intent and customer requirements. To do so, the digital twin is insufficient possibilities for synchronization between the physical and the digital world to establish closed loops:

- the missing of high-fidelity models for simulation and virtual testing at multiple scales,
- the lacking uncertainty quantification for such models,
- the difficulties in the prediction of complex systems, as well as the challenges for gathering and processing large data sets.

Required background of the student: Mechanical / Manufacturing engineering, Data mining

A list of 5(max.) representative publications of the group:

- HUANG, Z., DANTAN, J.-Y., ETIENNE, A., BONNET, N., RIVETTE, M., “Geometrical deviation identification and prediction method for Additive Manufacturing”, 2018, Rapid Prototyping Journal, in press.
- BEAUREPAIRE, P., MATTRAND, C., GAYTON, N., DANTAN, J.-Y., “Tolerance Analysis of a Deformable Component Using the Probabilistic Approach and Kriging-Based Surrogate Models”, 2018, ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, 4 (3)
- MORSE, E., DANTAN, J.-Y., ANWER, N., SÖDERBERG, R., MORONI, G., QURESHI, A., JIANG, X., MATHIEU, L., “Tolerancing: Managing uncertainty from conceptual design to final product”, 2018, CIRP Annals, 67 (2), pp. 695-717.
- HOMRI, L., GOKA, E., LEVASSEUR, G., DANTAN, J.-Y., “Tolerance analysis — Form defects modeling and simulation by modal decomposition and optimization”, 2017, CAD Computer Aided Design, 91, pp. 46-59.
- DANTAN, J.-Y., HUANG, Z., GOKA, E., HOMRI, L., ETIENNE, A., BONNET, N., RIVETTE, M., “Geometrical variations management for additive manufactured product”, 2017, CIRP Annals - Manufacturing Technology, 66 (1), pp. 161-164.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Industrial Engineering, Production Engineering

ParisTech School: Arts etMétiersParisTech campus de Metz

Title:Quality Management Framework for Additive Manufacturing Product and Process

Advisors: Pr. Ali SIADAT ali.siadat@ensam.eu
Dr.Alaa HASSANalaa.hassan@univ-lorraine.fr
Dr.Lazhar HOMRI lazhar.homri@ensam.eu

Short description of possible research topics for a PhD:
Additive manufacturing (AM)is a key component of a newindustrial revolution which is increasinglyintroducedinthe traditional manufacturing industry.However, it is still hampered by low productivity, poor and uncertainty of final productquality.Moreover, manufacturing should not be limited to AM because traditional fabrication processes are still reasonable.In this context, it is critical to assess and ensure quality in order to achieve a reliable AM process. Many qualitative and quantitative methodsare used to provide measures on manufacturing capability and to assess product quality.An adapted quality management framework is required to support the entire fabrication process chain. The topics to be addressed include software and data input, product understanding, AM equipment qualification, process understanding and continuous process verification.The interaction between input materials, process controls, and final outcomes of AM must beanalyzed.

The main objectives of the proposal are:

1. Development ofa quality management approachrelating product specifications and process parameters in order to assess the final product quality.
2. Conducting case studies on products fabricated by Fused Deposition Modeling (FDM) process.

Required background of the student:
The candidate must have a master degree in industrial, mechanical or production engineering. Skills in production management and programming will be appreciated.

A list of 5(max.) representative publications of the group:

[1] A. Hassan, A. Siadat, J. Dantan, and P. Martin, "Conceptual process planning – an improvement approach using QFD , FMEA , and ABC methods," *Robot. Comput. Integr. Manuf.*, vol. 26, no. 4, pp. 392–401, 2010.

[2] H. Rostami, J. Dantan, and L. Homri, "Review of data mining applications for quality assessment in manufacturing industry : support vector machines," vol. 401, 2015.

[3] H. Fei, X. Jinwu, L. Min, and Y. Jianhong, "Product quality modelling and prediction based on wavelet relevance vector machines," *Chemom. Intell. Lab. Syst.*, vol. 121, pp. 33–41, 2013.

[4] W. Y. Yeong and C. K. Chua, "A quality management framework for implementing additive manufacturing of medical devices," *Virtual Phys. Prototyp.*, vol. 8, no. 3, pp. 193–199, 2013.

[5] M. K. Thompson *et al.*, "Design for Additive Manufacturing: Trends, opportunities, considerations, and constraints," *CIRP Ann. - Manuf. Technol.*, vol. 65, no. 2, pp. 737–760, 2016.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Industrial Engineering, Mechanical Engineering, Production Engineering

ParisTechSchool: Arts et Métiers ParisTech campus de Metz

Title:Development of process planning system for hybrid manufacturing

Advisors: Pr. Ali SIADAT ali.siadat@ensam.eu
Dr.Alaa HASSANalaa.hassan@univ-lorraine.fr

Short description of possible research topics for a PhD:
The on-going industrial trend toward production of highly complex and accurate part geometries with reduced costs has led to the emergence of hybrid manufacturing processes where two or more manufacturing processes are combined whereby the advantages of each discrete process can be exploited synergistically. However, in this PhD thesis, the focus will be on additive and substantive manufacturing process. Processes planning is to definethe processes and the tools that will be used tomanufacture specific part and to assembly a specificsystem.Atypical process plan includes detailed drawings, routing sheets,material, tooling, fixtures, part programs, cost and time data. Research on process planning for subtractive processes has been widely developed since many decades. Nevertheless, it is necessary to take into account the potential of additive manufacturing technology in the industry of the future.Thus, the problem to be addressed is the combination between Additive and Subtractive Manufacturing to meet the industrial challenges in the reduction of tool wear and production time and cost and the increase of machining efficiency with specified tolerancesand surface finish.

The main objectives of the proposal are:

1. Development of a process planning framework for additive/subtractive processes based on product features and process planning scenarios.
2. Proposal ofcost and time estimation models for the process planning scenarios to find the best one.
3. Testing and validating the proposed framework using differentindustrial case studies.

Required background of the student:
The candidate must have a master degree in industrial, mechanical or production engineering. Skills insystems engineeringand programming will be appreciated.

A list of 5(max.) representative publications of the group:

[1] KhaleeqU, Siadat A, Rivette M, Baqai A, 2016 "Integrated product-process design to suggest appropriate manufacturing technology : a review" Int. J. Adv. Manuf. Technol., DOI 10.1007/s00170-016-9765-z
[2] Chu, Won-Shik, et al., 2014 "Hybrid manufacturing in micro/nano scale: A Review" International Journal of Precision Engineering and Manufacturing-Green Technology 1.1: 75-92.
[3] Zhu Z, Dhokia V, Nassehi A, Newman ST, 2013 "A Review of Hybrid Manufacturing Processes - state of the art and future perspectives" Int J Comput Integr Manuf. 26 (7):596-615
[4] Karunakaran K, Suryakumar S, Pushpa V, Akula S,2010"Low cost integration of additive and subtractive processes for hybrid layered manufacturing" Robot Comput-Integr Manuf. 26 (5):490-499

Research Topic for the ParisTech/CSC PhD Program

Subfield New Forming Process and Processus Eng., and material Eng,
Field:: Design, Industrialization； Materials Science, Mechanics, Fluids

ParisTech School: LCFC METZ, Arts et Métiers

Title:Identification of parameters control and Improvement from thixoforging process of aluminums (vs Steel)
Advisor(s): Eric BECKER, eric.becker@ensam.eu, Pr. Régis BIGOT
Short description of possible research topics for a PhD:
Thixoforging is a manufacturing process of metal alloys at semisolid state. Semisolid state is obtained by heating the material from the solid state, up to a temperature within the solidus-liquidus temperature range. Since always, Industry minimizes manufacturing process plan and increases mechanical behaviour. In this topic, the thixoforging process offers important perspectives. It is on the way of industrial development between casting and forging process thanks the typical rheological behaviour of the semisolid material. For thixoforging, the liquid fraction is quite low, less than 20% and it is generally obtained by heating from raw material with an inductive furnace.
This research work must contribute to improve comprehension of the aluminium behaviour during thixoforging and define the application field for this process. To achieve this goal, experimental testing with device will must be use and develop. The main thixoforging parameters to shape these alloys will be identify and study such as the forming speed, the initial steel temperature, the initial tool temperature, etc. The quality of the thixoforged parts must be study and characterize by the macrographic and micrographic observations of their metallurgical structure and mechanical tests or with other means that will be choise. The tests can be compared with simulations in order to determine and improve the predictive model capacity implemented in Forge2007®software.

Required background of the student: (Which should be the main field of study of the applicant before applying)
The student must be have a background in forming process, steel and aluminum material (and in preference in semi-solid state), and perhaps eng. Software Catia® and Forge®. He need have a good approach with experimental studies.

A list of 5(max.) representative publications of the group: (Related to the research topic)

- Becker, E., Bigot, R., Rivoirard, S., Faverolle, P. (2017). EXPERIMENTAL INVESTIGATION OF THE THIXOFORGING OF TUBES OF LOW-CARBON STEEL. Journal of Materials Processing Technology, 1 Oct 2017, PROTEC15423
- Gu, G. C., Pesci, R., Becker, E., Langlois, L., & Bigot, R. (2014). In Situ Microstructure Observation of Steel Grades in the Semi-Solid State for Thixoforging Process by Using Confoncal Laser Scanning Microscopy. Solid State Phenomena, 217-218, 15–22. doi:10.4028/www.scientific.net/SSP. 217-218.15. ISBN: 978-303835220-4.
- [Favier, V., Becker, E., & Bigot, R. (2014). Investigation of Parameters Promoting Hot Cracking during Semi-Solid Forming Processes. Solid State Phenomena, 217-218, 281–285. doi:10.4028/www.scientific.net/SSP.217-218.281.
- Bigot, R., Becker, E., &Langlois, L. (2013). Some approaches on industrialization of steel thixoforging processes. Solid State Phenomena, 192-193, 521-526, ISBN: 978-303785481-5.
- Neag, A., Favier, Véronique, Pop, M., Becker, E., Bigot, R, 2012. Effect of experimental conditions on 7075 aluminium response during thixoextrusion. Key Engineering Materials 504-506, 345–350. ISBN: 978-303785366-5.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Design, Industrialization

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…) :Inspection, Metrology, Mathematics

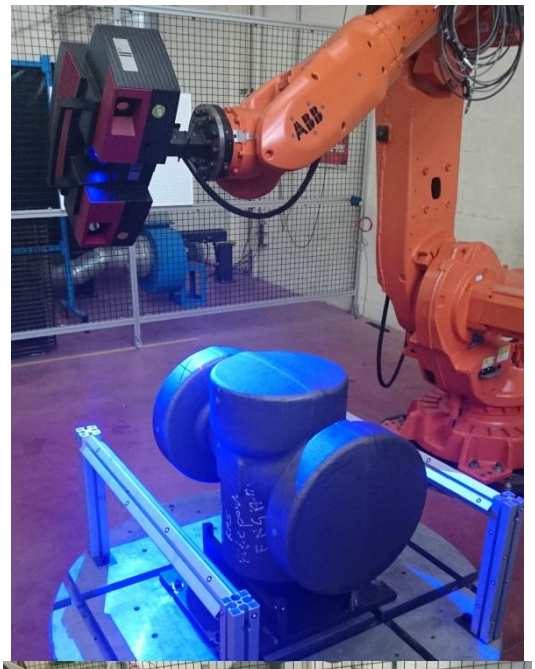
Title:Influence of stereovision scanning strategies on the accuracy of geometrical and dimensional measurement evaluations

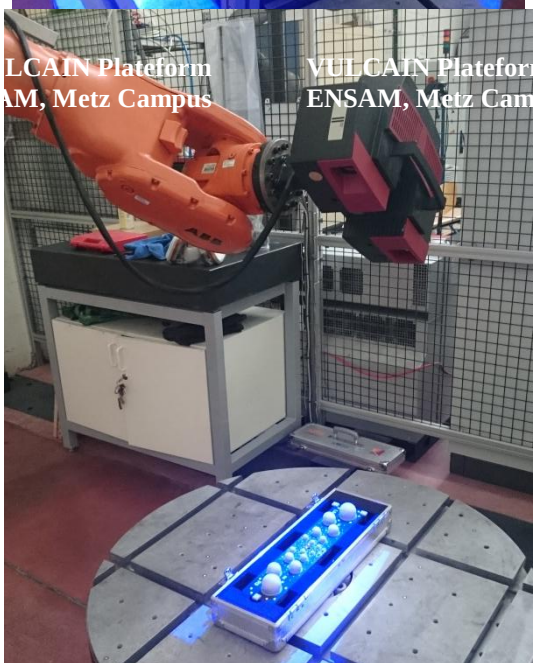
ParisTech School:Arts et Métiers ParisTech

Advisor(s) Name: Pr. BIGOT Régis, BAUDOUIN Cyrille
Advisor(s) Email:regis.bigot@ensam.eu; cyrille.baudouin@ensam.eu
(Lab, website):LCFC,http://lcfc.ensam.eu/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Stereovision allows to scan workpieces in 3 dimensions and to export an image with a large number of points. Used for reverse engineering applications for a long time, stereovision is increasingly used for shape, dimensions or geometric constraints inspection. On the one hand, this technology is much faster than contact measurement techniques such as dynamic probes associated with a coordinates measuring machine (CMM). On the other hand, measurement uncertainties are up today far below those obtained with a CMM. But it was found that the quality of the measurement information could be variable depending on the strategy of workpiece 3D-scanning with the stereovision device. Therefore, we could imagine that it is possible to establish good practices protocols for the number and the orientation of the different scanning points of view according to the defect which we want to evaluate.
The PhD proposal deals with the research of best measurement strategies by stereovision to evaluate dimensions (*diameters, distances, ...*), form deviations (*straightness, flatness, circularity, cylindricity, or any profile or surface form*), orientation deviations (*parallelism, perpendicularity, inclination*), and positional deviations (*concentricity, symmetry, localization*). For this purpose, an artefact must be designed and machined. It must be long enough to also evaluate the impact of the propagation of successive views association on the reconstruction of the whole workpiece. Then, this artefact will be rigorously inspected on CMM following an inter-comparison protocol which will allow to know the exact geometry of the artefact with the least possible uncertainties. Therefore, several stereovision measurement strategies will be tested and compared against the reference measurements to estimate differences in accuracy for trueness and repeatability. The strategy of positioning reference points for the combination of different views, such as the impact of the number of reference points and their positioning (*on the part, or on a frame*) will also be evaluated. The use of photogrammetry to accurately determine position of reference points may also be considered to evaluate the improvement it brings to the results.
All of these experiments should lead to good practices recommendations in order to improve accuracy on 3D-scanning by stereovision.





Scan of a valve body

Scan of calibrated balls

Required background of the student: (Which should be the main field of study of the applicant before applying)

- Knowledge in inspection, in contactless metrology (3D-scanning by stereovision) if possible
- Applied mathematics

A list of 5(max.) representative publications of the group: (Related to the research topic)

Until today, we used 3D-scanning as a tool to inspect and to investigate parts to better understand interactions between workpiece and process. Although stereovision systems are

famous to be flexible systems, we noticed an influence of acquisition strategies on accuracy so we want to develop this new activity.

C. Gutierrez, L. Langlois, C. Baudouin, R. Bigot, E. Frémeaux ; “Impact of tool wear on Cross wedge rolling process stability and on product quality”. AIP Conference Proceedings, vol. 1896, October 2017. doi: 10.1063/1.5008221

R. Husson, C. Baudouin, R. Bigot, E. Sura ; “Consideration of residual stress and geometry during heat treatment to decrease shaft bending”, International Journal of Advanced Manufacturing Technology - Vol. 72, n °9-12, pp.1455-1463, 2014.

C. Baudouin, R. Bigot, S. Leleu, P. Martin ; “Gear geometric control software : approach by entities”, International Journal of Advanced Manufacturing Technology, vol. 38, issue 1-2, pp. 120-129, 2008.

Research Topic for the ParisTech/CSC PhD Program

Field: Design, Information and Communication Sciences and Technologies
Subfield: Additive Manufacturing, Augmented Reality, Design Methodology, Creativity, Computer Graphics.

Title:Contribution to the integration of Additive Manufacturing and Augmented Reality in early design phases to foster Creativity

ParisTech School:	Arts et Métiers ParisTech	
Advisor(s) Name:	Dr. Frédéric Segonds (HDR)	Dr. Ruding Lou
Advisor(s) Email:	frederic.segonds@ensam.eu,	ruding.lou@ensam.eu
(Lab, website):	LCPI: http://lcpi.ensam.eu/	LISPEN: http://lispen.ensam.eu/

Short description of possible research topics for a PhD:
In the product design process, early stages are crucial as 80% of the design costs are engaged during these phases. Creativity is among one of the most important early activity as it allows to create breakthrough innovative products. Ideas are usually produced from inspirational sources such as images, 3D representations etc. These ideas are then retranscribed in ideas sheets to allow to select one (or more) concept to develop and industrialize.

As part of Industry 4.0, the idea generation phase can be enriched by the manipulation of physical objects made in Additive Manufacturing (AM). These objects can be produced on the fly to faithfully represent a concept to develop. In order to make this manipulation even more realistic, Augmented Reality (AR) technologies make it possible to apply a color and texture to a low-fidelity model.It allows users to see different appearances of a physical prototypes through the AR device and, at the same time, users can touch physically the object. Furthermore, withAR users can even change the shape and do some intuitive shape design activities. AR usually allows people to interact with virtual 3D mock-up integrated in the real world.The coupling of the two technologies (AM&AR) will thus favor the innovation of the design teams.

The aim of this PhD is to device and experiment AM&ARapplicationsin the product design creativity activities in order answer the following research question : can experiencing AM&ARtechnologies foster creativity and innovation?

Required background of the student:
Product design, programming. Interest for AM&AR technologies

A list of 5(max.) representative publications of the group: (Related to the research topic)

- Laverne, F., **Segonds, F.**, Anwer, N., & Le Coq, M. (2015). Assembly based methods to support product innovation in Design for Additive Manufacturing: An exploratory case study. Journal of Mechanical Design, 137(12)
- Rias, A. L., **Segonds, F.**, Bouchard, C., & Abed, S. (2017). Towards additive manufacturing of intermediate objects (AMIO) for concepts generation. International Journal on Interactive Design and Manufacturing (IJIDeM), 11(2), 301-315.
- B. Li, **R. Lou**, **F. Segonds** , F. Merienne, "Multi-user interface for co-located real-time work with digital mock-up: a way to foster collaboration?". International Journal on Interactive Design and Manufacturing, 11(3): 609–621. August 2017.
- B. Li, **F. Segonds**, C. Mateev, **R. Lou**, F. Merienne, "Design in context of use: An experiment with a multi-view and multi-representation system for collaborative design", Journal of Computers in Industry, Volume 103, Pages 28-37, 2018.
- B. Faliu, A. Siarheyeva, **R. Lou**, F. Merienne, "Design and prototyping of an interactive virtual environment to foster citizen participation and creativity in urban design", 27th International Conference on Information Systems Development (ISD), Lund, Sweden, August 2018.

Research Topic for the ParisTech/CSC PhD Program

Fields: 11. Design, Industrialization,
12. Life Science and Engineering,
13. Urban planning, Transport

Subfield: Product Design, Mechanical Engineering, Design

Title: How Bio-Inspired Design can help designers to innovate for the future mobilityindustry?

ParisTech School: Arts et Métiers ParisTech

Advisor(s) Name: Pr. AmézianeAoussat, Dr. Nicolas Maranzana
Advisor(s) Email: nicolas.maranzana@ensam.eu
(Lab, website): Product Design and Innovation Lab (http://lcpi.ensam.eu)

Short description of possible research topics for a PhD:

Life on Earth exists for already 3.8 billion years. During this period, evolution, selection, extinction and speciation have allowed life adaptation to our current world. Life is a powerful and infinite source of inspiration.
Bio-inspiration consists in drawing inspiration from the life mechanisms to design technological solutions. In other words, to appreciate the richness of nature to make it a driving force for innovation. Leonardo da Vinci was a pioneer in this field by drawing flying machines inspired by birds. Since then, many inventions have been based on the ingenuity of nature such as Velcro, Shinkansen, and so more.
Bio-inspiration needs a methodological framework to systematize its use, to anchor it as a reliable and reproducible innovation strategy. Methods and tools have to be developed to help and support designers in their activities.
Previous research in our labformalized a biomimeticsunifiedproblem-drivenprocessand provided a classification of available tools (BiomimeTree). It appears that this model is complex and that several of its stages don't have an appropriate tool, which make the process difficult to achieve by a designer. This thesis will therefore focus on removing these brakes and developing specific tools to help designers in this process, particularly in the context of finding innovative and bio-inspired solutions (products / services / organizations) for the mobility of tomorrow in urban areas.

Required background of the student:
Master Degree in Product Design, Mechanical Engineering and/or Design

A list of 5 (max) representative publications of the group:

- Graef, E., **N. Maranzana** and **A. Aoussat** (2018). Role of biologists in biomimetic design processes: preliminaryresults. International Design Conference (Design'18), Dubrovnik, Croatia.
- Fayemi, P.E., K. Wanieck, C. Zollfrank, **N. Maranzana** and **A. Aoussat** and G. Bersano (2017). Biomimetics: Process, tools and practice. Bioinspiration&Biomimetics, Volume 12, Number 1.
- Wanieck, K., P.E. Fayemi, **N. Maranzana**, C. Zollfrank and S. Jacobs (2017). Biomimetics and its tools. Bioinspired, Biomimetic and Nanobiomaterials, Volume 6, Issue 2, pp. 53-66.
- Fayemi, P.E., T. Chekchak, **N. Maranzana**, **A. Aoussat** and G. Bersano (2015). Modelingbiologicalsystems to facilitatetheirselectionduring a bio-inspired design process. 20th International Conference on Engineering Design (ICED'15), Milano, Italia.

***LEM3, UMR 7239, CNRS*Research Topic for the ParisTech/CSC PhD Program**

****Field (cf. List of fields below):*** Materials Science, Mechanics, Fluids
Subfield: Mechanical engineering

Title: Calorimetric manifestations of failure mechanisms within thermoplastic composite materials: application for fatigue life prediction of composite automotive components

ParisTech School: ENSAM – Arts et Métiers ParisTech
Advisor(s) Name: Pr. Fodil Meraghni, Dr. Adil Benaarbia
Advisor(s) Email: fodil.meraghni@ensam.eu, adil.benaarbia@ensam.eu
(Lab, website): LEM3, UMR-CNRS 7239. http://www.lem3.univ-lorraine.fr/

Short description of possible research topics for a PhD:
This PhD project aims at investigating the leading failure and damage mechanisms involved during the short-term (impact) and long-term (fatigue, creep, etc.) deformation of fiber-reinforced thermoplastics (e.g. internal storage and release of energy, irreversible phenomena due to dissipation, thermomechanical coupling, etc.). Coupled to efficient mathematical framework and its related algorithms, this research work will involve two full-field measurement techniques (digital image correlation and infrared thermography) and finite element modeling investigations. The outcomes of this research work will mark a major leap forward into the thermomechanical consistency of some classical constitutive models used in the automotive industry for structural durability prediction. It also will shed a greater insight on the various relations that may exist between the internal microstructural transformations occurring into the composite material and the energy terms arising from the inelastic deformation.

Required background of the student:
Applicants should have, or expect to achieve at least a Master's degree (or an equivalent overseas degree) in Mechanical Engineering, Materials Science, Applied Mathematics or a related subject. Candidates with suitable experience and strong capacity in numerical modeling, experimental testing and/or measurement skills are particularly welcome to apply.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. A Benaarbia, A Chrysochoos, G Robert. Fiber orientation effects on heat source distribution in reinforced polyamide 6.6 subjected to low cycle fatigue. **Journal of Engineering Mathematics** 90 (1), 13-36
2. A Benaarbia, A Chrysochoos, G Robert. Thermomechanical behavior of PA6. 6 composites subjected to low cycle fatigue. **Composites Part B: Engineering** 76, 52-64
3. MF Arif, N Saintier, F Meraghni, J Fitoussi, Y Chemisky, G Robert. Multiscale fatigue damage characterization in short glass fiber reinforced polyamide-66. **Composites Part B: Engineering** 61, 55-65
4. MF Arif, F Meraghni, Y Chemisky, N Despringre, G Robert. In situ damage mechanisms investigation of PA66/GF30 composite: Effect of relative humidity. **Composites Part B: Engineering** 58, 487-495
5. G Chatzigeorgiou, N Charalambakis, Y Chemisky, F Meraghni. Thermomechanical Behavior of Dissipative Composite Materials. Elsevier. Book ISBN: 9781785482793. Edited by **ISTE Press – Elsevier. 2018**.https://doi.org/10.1016/B978-1-78548-279-3.50001-4

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids
Subfield: Mechanical Engineering
Title: Grain boundary formulation to investigate size effects on the formability of ultra-thin sheet metals.
ParisTech School: Arts et Métiers ParisTech
Advisor(s):

- Farid ABED-MERAIM (Full professor, LEM3): farid.abed-meraim@ensam.eu
- Mohamed JEBAHI (Associate professor, LEM3): Mohamed.jebahi@ensam.eu

Short description of possible research topics for a PhD:
Due to the increasing trend towards miniaturization, ultra-thin sheet metals have become widely used in various high technology fields, such as microelectronics and microbotics. However, when the thickness of a sheet decreases, some parameters, such as grain size and number of shallow grains, remain unchanged. This may have a strong influence on the mechanical properties, e.g., the ductility limit, of this sheet. Consequently, knowledge and understanding of conventional sheet behavior are no longer applicable to ultra-thin sheets. Further research effort is needed to meet the emerging scientific challenges posed by the technological progress towards miniaturization. In a current PhD project on the subject, a strain gradient crystal plasticity model is developed to describe size effects. This model, which is currently under validation, shows great capabilities and provides very promising results for sheets containing sufficient number of grains in the thickness. However, its use for sheets with only few grains (less than two) in the thickness would be critical. Indeed, at this number of grains, the grain boundary effects become extremely important. As continuation of this work, the present project aims to extend the newly developed model in order to account for the interaction between dislocations and grain boundaries. The extended model will after be coupled with plastic instability criteria to study the impact of size effects on the ductility of ultra-thin sheet metals without constraints on the number of grains in the thickness.

Required background of the student:
Computational mechanics, Material behavior, Sheet metal forming processes

A list of 5(max.) representative publications of the group:

[1] Ben Bettaieb, M. and Abed-Meraim, F., *Effect of kinematic hardening on localized necking in substrate-supported metal layers*, International Journal of Mechanical Sciences 123 (2017),pp. 177-197.

[2] Ben Bettaieb, M. and Abed-Meraim, F., *Theoretical and numerical investigation of the impact of out-of-plane compressive stress on sheet metal formability*, International Journal of Mechanical Sciences 130 (2017), pp. 244-257.

[3] Bouktir, Y. and Chalal, H. and Haddad, M. and Abed-Meraim, F., *Investigation of ductility limits based on bifurcation theory coupled with continuum damage mechanics*, Materials & Design 90 (2016), pp. 969-978.

[4]Akpama, H.K.and Ben Bettaieb, M. and Abed-Meraim, F., *Numerical integration of rate-independent BCC single crystal plasticity models: comparative study of two classes of numerical algorithms*,International Journal for Numerical Methods in Engineering108 (2016), pp. 363-422.

[5] Ben Bettaieb, M. and Abed-Meraim, F., *Investigation of localized necking in substrate-supported metal layers: Comparison of bifurcation and imperfection analyses*, International Journal of Plasticity 65 (2015), pp. 168-190.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Materials Science, Mechanics, Fluids
Subfield: Mechanical Engineering

Title: Multiscale fully coupled thermo-piezo-mechanical modeling of fiber reinforced piezoelectric actuators accounting for viscous and damage mechanisms

ParisTech School: ENSAM Campus Metz

Advisor(s) Name: Pr. Fodil Meraghni, Dr. George Chatzigeorgiou
Advisor(s) Email: ***fodil.meraghni@ensam.eu***, ***georges.chatzigeorgiou@ensam.eu***
(Lab, website): LEM3, UMR-CNRS 7239.http://www.lem3.univ-lorraine.fr/

Short description of possible research topics for a PhD:
The electromechanical behavior of piezoelectric thermoplastic composites and its sensitivity to temperature variations will be examined in this work. The aim of the proposed Ph.D. is to develop a novel micromechanics framework that accounts for the microstructural complexity, the various nonlinear mechanisms and the thermo-electro-mechanical couplings of the piezoelectric glass fiber composites during cyclic actuation. When considering repeated loading/unloading conditions at relatively high stresses, the activation of viscous mechanisms produce significant intrinsic dissipation, causing in return a strong interaction between thermal, electrical and mechanical fields. This interaction needs to be integrated properly into the proposed homogenization scheme, in order to obtain a better estimation of the macroscopic response of the composite and a more accurate prediction of the various fields that effect the cyclic actuation performance.

Required background of the student: Mechanics of Materials, Continuum Mechanics, Finite Elements, Applied Mathematics and/or Numerical Modeling.

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] G. Chatzigeorgiou, A. Javili, F. Meraghni, 2018. Micromechanical method for effective piezoelectric properties and electromechanical fields in multi-coated long fiber composites. **International Journal of Solids and Structures**, in press.

[2] G. Chatzigeorgiou, F. Meraghni, A. Javili, 2017. Generalized interfacial energy and size effects in composites. **Journal of the Mechanics and Physics of Solids**, 106, 257-282.

[3] M. Hossain, G. Chatzigeorgiou, F. Meraghni, P. Steinmann, 2015. A multi-scale approach to model the curing process in magneto-sensitive polymeric materials. **International Journal of Solids and Structures**, 69-70, 34-44.

[4] M. F. Arif, N. Saintier, F. Meraghni, J. Fitoussi, Y. Chemisky, G. Robert, 2014. Multiscale fatigue damage characterization in short glass fiber reinforced polyamide-66. **Composites Part B: Engineering**, 61, 55-65.

[5] Z. Jendli, F. Meraghni, J. Fitoussi, D. Baptiste, 2009. Multi-scales modelling of dynamic behaviour for discontinuous fibre SMC composites. **Composites Science and Technology**, 69 (1), 97-103.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Information and Communication Sciences and Technologies

Subfield: Computer Science, Virtual reality

ParisTech School:EcoleNationaleSupérieured'Artset Métiers Paristech - ENSAM

***Title*:Intuitive 3DInteractions for Mobile Mixed Reality**

Advisor(s) Name: Fakhreddine Ababsa, Full Professor, Arts & Métiers ParisTech

Advisor(s) Email:Fakhreddine.Ababsa@ensam.eu
(Lab, website):Institut Image, LISPEN. http://institutimage.ensam.eu/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Natural User Interfaces (NUI) aim to provide multimedia applications with natural and intuitive controlling operations, such as touch, sound and motion. To provide such interfaces, special devices are necessary to detect and recognize a human's natural input signal. In recent years, several interaction techniques have been developedusing human motion detection and recognition devices like Kinect or Leap Motion. However, such approachesare appliedonly in simple and controlled environments. Creating intuitive ways to interact with 3D content in a mobile mixed reality environment still one of the major challenges of current computer science. The aim of this PhD project is to investigate novel concepts to naturally interact with 3D virtual objects displayed on a see-through glass (e.g. Hololens). 3D gesture tracking / recognition based on machine learning approaches will be investigatedas well as the selection/manipulation of virtual objects in mixed reality context. An in-depth evaluation procedure on several use cases will be carried out in order to study how these approaches would affect the user's performances.

Required background of the student: (Which should be the main field of study of the applicant before applying)

The candidate should have aMaster degree or equivalent in computer science, or related disciplines. Required skills are experience in C++ software development, Machine learning and pattern recognition, applied mathematics, and a good command of English (reading/writing/speaking. In addition, the successful candidate will be highly self-motivated, passionate about his/her work, and has good ability to work both independently as well as in a team in a multidisciplinary environment.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. Cyrille Migniot, Fakhreddine Ababsa:Hybrid 3D-2D human tracking in a top view. J. Real-Time Image Processing 11(4): 769-784 (2016)
2. HajarHiyadi, Fakhreddine Ababsa, Christophe Montagne, El-Houssine Bouyakhf, FakhitaRegragui: Adaptive dynamic time warping for recognition of natural gestures. IPTA 2016: 1-6

3. M. Ali Mirzaei, Jean-RémyChardonnet, Frédéric Mérienne, A. Genty:Navigation and interaction in a real-scale digital mock-up using natural language and user gesture. VRIC 2014: 28:1-28:4

4. Hamid Hrimech, Leila Alem, Frédéric Mérienne: How 3D Interaction Metaphors Affect User Experience in Collaborative Virtual Environment. Adv. Human-Computer Interaction 2011

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Information and Communication Sciences and Technologies

Subfield: Robotics

Title:**Human–Robot Collaboration in Integrated Manufacturing using Augmented Reality**

ParisTech School:Ecole Nationale Supérieure d'Arts et Métiers Paristech - ENSAM

Advisor(s) Name: Fakhreddine Ababsa, Full Professor, Arts & Métiers ParisTech
Advisor(s) Email:Fakhreddine.Ababsa@ensam.eu

(Lab, website): Institut Image , LISPEN. http://institutimage.ensam.eu/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

In the industry of the future, robots would work in collaboration with human by jointly performing the assigned tasks and sharing the same workspace. Hence, their actions must be controlled in real time according to the human actions. Visual tracking would allow the worker to be located in the workspace and to recognize his gestures in order to anticipate the robot's control avoiding any collision with him. The aim of this PhD proposal is to investigate new approaches for human-robot collaboration using augmented reality. The idea is to develop an augmented reality system, which allows the worker to visualize simultaneously and in real time the robot's control information and also the instructions to be performed by the user. 3D human tracking and gesture recognition based on machine learning approaches will also be investigated. A depth sensor placed in top will be used, the acquired data will be analysed to detect the operator's presence area and to recognize his gesture. Natural user interface will be developed in order to control the application: changingthe context/scenario of AR, stopping the robot, etc.

Required background of the student: (Which should be the main field of study of the applicant before applying)
The candidate should have aMaster degree or equivalent in Robotics, computer science, or related disciplines. Required skills are experience in C++ software development, Machine learning and pattern recognition, applied mathematics, and a good command of English (reading/writing/speaking. In addition, the successful candidate will be highly self-motivated, passionate about his/her work, and has good ability to work both independently as well as in a team in a multidisciplinary environment.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. Cyrille Migniot, Fakhreddine Ababsa:Hybrid 3D-2D human tracking in a top view. J. Real-Time Image Processing 11(4): 769-784 (2016)

2. Madjid Maidi, Fakhreddine Ababsa, Malik Mallem, Marius Preda: Hybrid tracking system for robust fiducials registration in augmented reality.Signal, Image and Video Processing 9(4): 831-849 (2015)

3. Hajar Hiyadi, Fakhreddine Ababsa, Christophe Montagne, El-Houssine Bouyakhf, Fakhita Regragui:A Depth-based Approach for 3D Dynamic Gesture Recognition.ICINCO (2) 2015: 103-110

4. Cyrille Migniot, Fakhreddine Ababsa: Part-based 3D Multi-person Tracking using Depth Cue in a Top View.VISAPP (3) 2014: 419-426

5. J. Chardonnet Interactive Dynamic Simulator for Multibody Systems. Chardonnet, J. International Journal of Humanoid Robotics, 9(3): 1250021–1,1250021–24. 2012.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Information and Communication Sciences and Technologies

Subfield: Computer Science

ParisTechSchool: Ecole Nationale Supérieure d'Arts et Métiers ParisTech - ENSAM

Title:**Interactive Augmented Reality Using Wearable Haptics Systems**

Advisor(s): Fakhreddine Ababsa, Full Professor,
Jean-Remy Chardonnet, Associate Professor,

Advisor(s) Email:Fakhreddine.Ababsa@ensam.eu. Jean-Remy.Chardonnet@ensam.eu
(Lab, website): Institut Image, LISPEN. http://institutimage.ensam.eu/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Today, Augmented Reality applications are already very convincing; they are widespread in many fields, especially in medicine, Education, and Industry. However, users are still not able to physically interact with virtual objects, thus limiting their presence sensation. Wearable haptics can bridge this gap between digital andphysical worldsand can provide the compelling illusion of touching superimposed virtual objects without constraining the motion or the workspace of the user.Integrating haptic devices in Augmented Reality Environments is a complex task that poses challenging issues such as haptic feedback, haptic augmentation, and real-virtual object interaction.The goal of this PhD proposal is tostudy these problems in order to develop a smart and efficient wearable haptics devicethat allows a user to naturally interact with virtual objects displayed through AR Glasses (e.g., Hololens). The project will focus on the development of direct touch solutions and their integration with see-through Augmented Reality. To this end,highly accurate calibration, system stability, and low latency are necessary. These points will also be tackled within this thesis.

Required background of the student: (Which should be the main field of study of the applicant before applying)

Applicants should have a Master degree or equivalent in a related discipline, such as software engineering, computer science, mechatronics, or a related field with programming skills, skills in electronics.
The ideal candidate should have some understanding in the area of virtual/augmented reality,computer vision, haptics, and simulation.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. M. Maidi, F. Ababsa, M. Mallem, M. Preda: Hybrid tracking system for robust fiducials registration in augmented reality. Signal, Image and Video Processing 9(4): 831-849 (2015)
2. F. Ababsa, Imane M. Zendjebil, Jean-Yves Didier, Malik Mallem:
   Smart Localization Using a New Sensor Association Framework for Outdoor Augmented Reality Systems. J. Robotics 2012: 634758:1-634758:15 (2012)

3. J.-C. Léon, T. Dupeux, J.-R. Chardonnet, et J. Perret, « Dexterous grasping tasks generated with an add-on end-effector of a haptic feedback system », Journal of Computing and Information Science in Engineering, vol. 16, n° 3, sept. 2016.
4. J.-R. Chardonnet et J.-C. Léon, « Interaction peripheral device capable of controlling an element for touching and grasping multidimensional virtual objects », US20150009145A1, 08-janv-2015.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field: Information and Communication Sciences and Technologies

Subfield: Geometry modelling, computer vision, virtual reality, augmented reality

Title:Shape modeling of the world through augmented reality

ParisTech School: Arts et Métiers
Advisor(s) Name: Prof. Fakhreddine ABABSA,Dr. Ruding LOU
Advisor(s) Email:Fakhreddine.ABABSA@ensam.eu, ruding.lou@ensam.eu
(Lab, website):http://institutimage.ensam.eu/

Short description of possible research topics for a PhD:
Nowadays the augmented reality (AR) technology becomes widely used in the daily life thanks to the newly innovated device such as Microsoft HoloLens. This technology usually allows people to interact with digital content in 3D (virtual mock-up) in the real world. In the literature, most of the research work have worked on how to visualize the virtual mock-up together with real elements, which let people believe it belongs to the real environment. The challenge was how to deduce the correct transformation (translation, rotation and scale) of the virtual mock-up according to the point of view on the real elements. Other works have illustrated various possibilities to interact with the virtual mock-up as what people can do with a real object. One application is to reshape or modify geometrically the virtual mock-up with the consideration of the real environment to which it should belong. **The contribution of thesis is to propose a new AR system that allows people to redesign virtually the shape of the real objects**. The objects in the real world will be digitalized at first and then inserted intoAR system to manipulate within in the real world. One major scientific challengeishow to handle the occlusion phenomena between the real and virtual objects?

Required background of the student:
Programming, geometric modeling, digitalization, mesh reconstruction and editing, computer vision and augmented reality.

A list of 5(max.) representative publications of the group: (Related to the research topic)

- H. Elchaoui Elghor, D. Roussel, **F Ababsa**, E.H. Bouyakhf, "3D Plane-Based Maps Simplification For RGB-D SLAM Systems". Journal of Theoretical & Applied Information Technology, Vol. 93 n°2, pp. 402 - 411, 2016.
- M. Maidi, **F. Ababsa**, M. Mallem, M. Preda. "Hybrid tracking system for robust fiducials registration in augmented reality". Journal of Signal, Image and Video Processing, Springer, Volume 9, Issue 4, pp 831–849, May 2015.
- **F. Ababsa**, M. Mallem. "Robust Camera Pose Tracking for Augmented Reality Using Particle Filtering Framework". International Journal of Machine Vision and Applications (MVA). Springer-Verlag. Vol.22, No 1, pp. 181-195, 2011.
- **R. Lou**, J-P. Pernot, A. Mikchevitch, P. Véron, Merging enriched Finite Element triangle meshes for fast prototyping of alternate solutions in the context of industrial maintenance,Computer-Aided Design,Volume 42, Issue 8, Pages 670-681, 2010.
- B. Li, F. Segonds, C. Mateev, **R. Lou**, F. Merienne,Design in context of use: An experiment with a multi-view and multi-representation system for collaborative design,Computers in Industry,Volume 103, Pages 28-37,2018.

Research Topic for the ParisTech/CSC PhD Program

Field: 11. Design, Industrialization

Subfield: Design Engineering / 3D Modeling

Title:Geometric simplification of digital CAD mock-up using substitution and envelope generation techniques exploiting explicit and implicit semantic information

ParisTech School: Arts et Métiers ParisTech

Advisor(s) Name: Pr. Philippe VERON
Advisor(s) Email:Philippe.Veron@ensam.eu
(Lab, website):*Laboratoire LISPEN lispen.ensam.eu / Carnot ARTS institute*www.ic-arts.eu

Short description of possible research topics for a PhD:
The digital mock-up is a key component in the innovative manufacturing product development process. It is an efficient support platform for multidisciplinary collaborative development of products which become increasingly complex and developed in an extended enterprise mode.
If the digital mock-up is mainly built the in product engineering phases, its progressive enrichment is leaded through its ability to unify all areas of the company with levels of details increasingly fine. This is an important objective to represent and simulate as close to reality the future product, manufacture it globally, but also assure its support all along its lifecycle, especially in an economic context where the supply chains are playing an increasingly critical role and where the markets targeted by companies become globalized. Therefore, this Digital Mock-Up becomes increasingly "heavy" particularly in terms of its geometric definition that is more and more detailed.
In this context, a challenge is to be able to exploit the 3D digital mock-up for all kinds of activities including computer simulation and visualization and using mobile media (tablets) more and more frequently used. For this, it is necessary to be able to simplify the 3D geometric representation of the model to make it compatible with the needs of the activity and with the associated constraints (size of problem, processing time, quality, real-time, ...). Current simplification techniques are mainly based on defeaturing approaches (removal of characteristics forms on the parts that constitute more or less important shape details), or on decimation approaches (reduction of the number of triangles associated with the polyhedral representation of the different parts). All these approaches are generally well suited if you do not simplify too much the initial shape and they generally give poor or even unusable results when we need highly simplified form (or get a very simple shape that look like the overall initial form). In addition, all these approaches work mainly for parts and rarely for assemblies. As a consequence, a first axis of this thesis work is to develop a new approach for the massive simplification of huge digital mock-ups based on a principle of shape substitutions (analysis of the initial shape and replacing it by one or more simple substitution shapes). Initially, work will focus on the part level (component) and can be extended / generalized to assemblies (assembly level).

Required background of the student: 3D CAD modeling, programming language, computer graphics

A list of 5(max.) representative publications of the group: (Related to the research topic)

https://scholar.google.fr/citations?user=qZ6InYkAAAAJ&hl=fr

Research Topic for the ParisTech/CSC PhD Program

Field:Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering – Fluid Dynamics

Title:Direct Numerical Simulation (DNS) of oil/water flows representative of oil spills in the ocean

ParisTech School: Arts et Metiers, Campus de Lille

Advisor(s) Name: Olivier Coutier-Delgosha & Annie-Claude Bayeul-Lainé
Advisor(s) Email:Olivier.coutier@ensam.eu&annie-claude.bayeul-laine@ensam.eu

(Lab, website):LMFL (Laboratoire de Mécanique des Fluides de Lille)
http://lmfl.cnrs.fr/en/home/

Short description of possible research topics for a PhD: After the Deepwater Horizon accident in the Gulf of Mexico in 2010, large funding has been mobilized for research activities devoted to oil spills and their effects. One question is about the interaction between the see water and the oil slicks and how the oil is mixed with the water and the atmosphere (creation of aerosols). Several experiments were conducted at Johns Hopkins university, including for example an oil plume at the bottom of a tank, with a water cross flow, or a rain drop falling on a water tank with oil slick at the surface, to mimic the effects of rain at the surface of the ocean, and oil slick at the surface of water in a wave tank. In the two first configurations, CFD has been already started at Arts et Metiers ParisTech. It is based on Direct Numerical Simulations of the oil/water/air mixture using the VOF (Volume of Fluid) approach available in the GERRIS code. The present research project is focused on the configuration of the wave tank. The challenge is to capture as well the large-scale dynamics of waves as the small-scale oil dispersion, especially the micro and nano droplets that are aerosolized in the air when dispersant is added to the oil. This last point is of primary interest for public health issues. The results will be validated by comparison with the experimental data obtained at JHU, and further investigation of the numerical results will enable to better characterize the small-scale mechanisms involved in the unsteady evolution of the oil/water/air mixture.

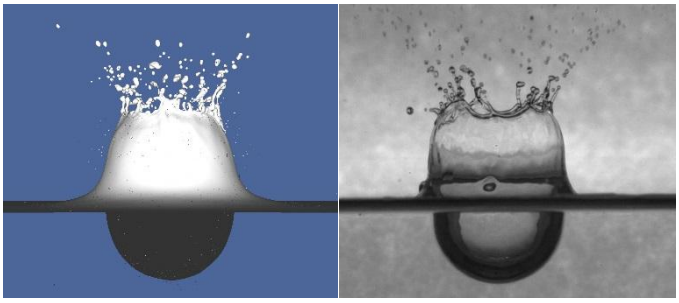


Fig. 1: A few ms after the impact of the rain drop at the surface of the tank: Comparison between the numerical result (on the left) and the experimental observation (on the right)

Required background of the student: fluid mechanics

A list of 5(max.) representative publications of the group: (Related to the research topic)

M. Ghandour, O. Coutier-Delgosha, D. Murphy&J. Katz (2016), Direct numerical modelling of raindrop impacting oil slicks, Presentation at the Gulf of Mexico Conference.

D. W. Murphy, L. Cheng, V. d'Albignac, D. Morra& J. Katz (2015), Splash behaviour and oily marine aerosol production by raindrops impacting oil slicks, J. Fluid Mech.**780**:536- 577.

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

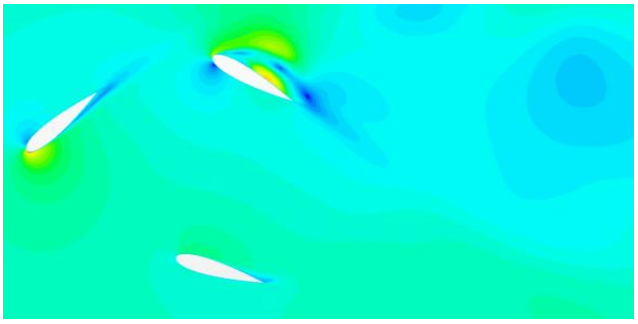
Subfield: Mechanical Engineering – Fluid Dynamics

Title:Numerical simulation, analysis, and optimization of an innovant trochoidal propeller
ParisTech School: Arts et Metiers, Campus of Lille

Advisor(s) Name: Annie-Claude Bayeul-Lainé & Olivier Coutier-Delgosha
Advisor(s) Email:annie-claude.bayeul-laine@ensam.eu&Olivier.coutier@ensam.eu

(Lab, website):LMFL (Laboratoire de Mécanique des Fluides de Lille)
http://lmfl.cnrs.fr/en/home/

Short description of possible research topics for a PhD: The operation of a trochoidal naval propeller is significantly more complex than classical propellers. Indeed, it is based on the rotation of several hydrofoils around a vertical axis, while each foil is also submitted to a periodic oscillation around its own axis. This kinematics is derived from the sculling movement, when a single oar is used to propel a ship by moving it over the stern. Its main advantage is an improved ship manoeuvrability, since it provides a thrust in any direction with a short time response.To maximize the efficiency, a detailed understanding of the internal flows is required. Modern CFD solvers, coupled with up to date optimization methods, offer promising capabilities on that level. An experimental activity is conducted at IRENav (French Naval Academy), while the numerical approach, which is the purpose of the present proposal, is performed at Art et Metiers Paristech.The present project is focused on the optimization ofthe foil kinematics and geometry. The objective is to obtain the maximum available hydraulic efficiency, based on the understanding of the multi-scale unsteady mechanisms in the rotor. CFD simulations will be performed with a URANS (Unsteady Reynolds Averaged Navier-Stokes) solver, as well in three dimensions (3D) in order to quantify precisely the propeller performance, as in 2D to conduct the optimization process. The influence of several parameters like the non-homogeneity of the upstream flow, the occurrence of cavitation, and the confinement (due for example to the vicinity of the ship hull) will be studied.



Required background of the student: fluid mechanics

A list of 5(max.) representative publications of the group: (Related to the research topic)

AC Bayeul-Lainé, S. Simonet, G. Bois: *Unsteady flow field in a mini VAWT with relative rotation blades: Analysis of temporal results*. IOP Conference Series Materials Science and Engineering 09/2013; 52. DOI:10.1088/1757-899X/52/5/052002

O. Coutier-Delgosha, F. Deniset, JA. Astolfi& JB.Leroux (2007), Numerical prediction of the cavitating flow on a two-dimensional symmetrical hydrofoil and comparison with experiments, *J. of Fluids Eng.* 129(3):279–292.

Research Topic for the ParisTech/CSC PhD Program

Fields: Computer science, Information and Communication Sciences and Technologies, Mathematics and their applications, Design& Industrialization.

ParisTech School: Arts et Métiers ParisTech – Campus of Aix-en-Provence

Title:**Deep learning for multimodal segmentation of point clouds for reverse engineering of mechanical assemblies**

Advisor(s):
Prof. Dr. Jean-Philippe PERNOT / jean-philippe.pernot@ensam.eu / http://lispen.ensam.eu/
Dr. Arnaud POLETTE / arnaud.polette@ensam.eu / http://lispen.ensam.eu/

Short description of possible research topics for a PhD:

This PhD program addresses the way point clouds generated from low-cost acquisition devices (e.g. Kinect, smartphones, pads) can be efficiently segmented using a deep learning strategy working on multimodal data. Such an approach is particularly interesting for the reverse engineering of mechanical assemblies in augmented reality (e.g. objects recognition or maintenance simulation).The main idea relies on the use of a common space, i.e. 2.5D, to process and analyze multimodal data. The first step(from 3D to 2.5D) relies on the use of a database of parameterized CAD models used to generate a huge set of classified instancesfor which several RGB-D images are computed. In a second step (training), those images are then used to train a Convolutional Neural Networks (CNN). Once the CNN has been tuned, the third step (recognition) consists inapplying the CNN to recognize mechanical components and parts in complex environments represented by 2.5D images. Those 2.5D images can be directly acquired by dedicated acquisition devices (e.g. Kinect, smartphones, pads), or generated from 3D point clouds obtained for instance with a laser scanner. The fourth step (segmentation) allows going back to 3D from the 2.5D images and segment the point clouds.The proposed approach will be implemented and validated on academic as well as on industrial examples.

Required background of the student: Computer science, computer vision, geometric modeling, computer-aided design

A list of 5(max.) representative publications of the group:
Danglade F., Pernot J-P., Véron P., « On the use of machine learning to defeature CAD models for simulation », Computer-Aided Design and Applications, vol. 11(3), pp. 358-368, 2014.
Danglade F., Pernot J-P., Véron P., Fine L., « A priori evaluation of simulation models preparation processes using artificial intelligence techniques », Computers in Industry, vol. 91, pp. 45-61, 2017.
Panchetti M., Pernot J-P., Véron P., « Towards recovery of complex shapes in meshes using digital images for reverse engineering applications », Computer-Aided Design, vol. 42(8), pp. 693-707, 2010.
Pernot J-P., Giannini F., Petton C., « Thin part identification for CAD model classification », Engineering Computations, vol. 32(1), pp. 62-85, 2015.
Polette A., Meunier J., Mari JL. (2017) « Shape-Curvature-Graph: Towards a New Model of Representation for the Description of 3D Meshes ». In: De Paolis L., Bourdot P., Mongelli A. (eds) Augmented Reality, Virtual Reality, and Computer Graphics. AVR 2017. Lecture Notes in Computer Science, vol 10325. Springer, Cham

Research Topic for the ParisTech/CSC PhD Program

Fields: Design& Industrialization, Computer science, Information and Communication Sciences and Technologies, Mathematics and their applications.

ParisTech School: Arts et Métiers ParisTech – Campus of Aix-en-Provence

Title:**Multimodal declarative modeling for fast sketching of draft CAD models in the creative design phases**

Advisor(s):
Prof. Dr. Jean-Philippe PERNOT / jean-philippe.pernot@ensam.eu / http://lispen.ensam.eu/
Dr. Arnaud POLETTE / arnaud.polette@ensam.eu / http://lispen.ensam.eu/

Short description of possible research topics for a PhD:
This PhD program addresses the way draft CAD models can be efficiently sketchedfrom a combination of multimodal inputs. Such an approach is particularly interesting in the creative design phases when the shapes are not yet fully defined and when the designer may be interested in describing his/her shapes using multiple modalities.The main idea relies on the development of a new declarative modeling framework which will drive an existing CAD modeler, and/or research prototype software,from a user-specifieddescription combiningthe use of a dedicated vocabulary/grammar as well as thepossible use of low-cost interaction devices.Severalmodules are foreseen. In a first step, the designer will describe his/her shape using a vocabulary and grammar and possibly using interaction devices such as a Leap Motion or a Kinect. Then, this description will be processedand transformed in a generic shape description, i.e. a set of generic geometric operations that can be used to obtain the shape whatever the CAD modeler or research prototype software are. At thisstage, the system will have to manage issues related to the possible incompleteness and/or inconsistency of the user-specified description. Finally, this generic shape description will be transformed in a set of geometric operations specific to a CAD modeler and/or research prototype software. The output of this modeling process will be a draft CAD model to be used and further refined in the later stages of the design process. The proposed framework will be implemented and validated on academic as well as industrial examples.

Required background of the student: Computer science, geometric modeling, computer-aided design

A list of 5(max.) representative publications of the group:
Cheutet V., Catalano C.E., Pernot J-P., Falcidieno B., Giannini F., Léon J-C., 3D Sketching for aesthetic design using Fully Free Form Deformation Features, Computers & Graphics, vol. 29(6), pp. 916-930, 2005.
Pernot J-P., Falcidieno B., Giannini F., Léon J-C., Incorporating free-form features in aesthetic and engineering product design: State-of-the-art report, Computers in Industry, vol. 59(6), pp. 626-637, 2008.
Gouaty G., Fang L., Michelucci D., Daniel M., Pernot J-P., Raffin R., Lanquetin S., Neveu M., Variational geometric modeling with black box constraints and DAGs, Computer-Aided Design, vol. 75-76, pp. 1-12, 2016.
Décriteau D., Pernot J-P., Daniel M., Towards a declarative modelling approach built on top of a CAD modeller, Computer-Aided Design and Applications, vol. 13(6), pp. 737-746, 2016.
Sadeghi S., Dargon T., Rivest L., Pernot J-P.,Capturing and analysing how designers use CAD software, Tools and Methods for Competitive Engineering (TMCE'16), Aix-en-Provence, France, vol. 1, pp. 447-458, 2016.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering; Material processing.

Title: Multiscale investigation of the thermal behavior of natural fiber composites for manufacturing applications

ParisTech School: Arts et Métiers (ENSAM)

Advisor(s) Name: Prof. Mohamed EL MANSORI; Dr. Faissal CHEGDANI
Advisor(s) Email:mohamed.elmansori@ensam.eu ; faissal.chegdani@ensam.eu
(Lab, website):*Mechanics, Surfaces and Materials Processing (MSMP) – EA7350*

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Natural fiber composites arouse the interest of industry and academia thanks to many economic, ecological and technical performances of natural fibers such as flax and hemp. However, manufacturing processes of natural fiber composites present some issues related to the multiscale complex structure of natural fibers which is a cellulosic structure completely different from the conventional fibers used in composite industry such as glass and carbon. Within MSMP laboratory, the multiscale issues of natural fiber composites have been investigated for the machining process in terms of surface finish [1], [2]. The machinability qualification of natural fiber composites requires selecting a pertinent scale that corresponds to the natural fibrous structure size [3]. Indeed, the mechanical response of natural fibers involves a mechanical scale effect that influences the cutting contact during machining [4]. Moreover, the machining behavior of natural fibers shows an important dependence on the temperature induced by cutting [5]. This requires a deep investigation on the thermal behavior of natural fiber composites at their different characteristic scales to understand the thermal effect on the cutting mechanisms. Starting from the nano-scale structure (cellulose microfibrils and amorphous natural polymers) to the micro-scale cell walls structure of elementary fibers and finally the overall macro-scale structure of natural fiber structure, the Ph.D. student must characterize the thermal behavior of each structural component in the corresponding scale to understand the thermo-mechanical failure behavior of natural fiber composites during machining.

Required background of the student: (Which should be the main field of study of the applicant before applying)

The PhD candidate must have a solid knowledge on mechanics of materials and should have the ability to characterize the thermo-mechanical behavior of different material types.

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] F. Chegdani, S. Mezghani, M. El Mansori, and A. Mkaddem, “Fiber type effect on tribological behavior when cutting natural fiber reinforced plastics,” *Wear*, vol. 332–333, pp. 772–779, Jan. 2015.
[2] F. Chegdani and M. El Mansori, “Mechanics of material removal when cutting natural fiber reinforced thermoplastic composites,” *Polym. Test.*, vol. 67, pp. 275–283, May 2018.
[3] F. Chegdani and M. El Mansori, “New multiscale approach for machining analysis of natural fiber reinforced bio-composites,” *J. Manuf. Sci. Eng.*, Aug. 2018.
[4] F. Chegdani, M. El Mansori, S. Mezghani, and A. Montagne, “Scale effect on tribo-mechanical behavior of vegetal fibers in reinforced bio-composite materials,” *Compos. Sci. Technol.*, vol. 150, pp. 87–94, Sep. 2017.
[5] F. Chegdani, B. Takabi, B. L. Tai, M. El Mansori, and S. T. S. Bukkapatnam, “Thermal Effects on Tribological Behavior in Machining Natural Fiber Composites,” *Procedia Manuf.*, vol. 26, pp. 305–316, Jan. 2018.

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids
Subfield: Mechanical Engineering

Title: Strengthen mechanism of *in-situ* metastable phase in laser additive manufactured aluminum alloy
ParisTech School:Paristech-Arts et Métiers

Advisor(s) Name: Mohammed ELMANSORI (Paristech-Arts et Métiers)
Nan KANG (Northwestern Polytechnical University)

Advisor(s) Email: **mohamed.el mansori@ensam.eu (M. ELMANSORI)**
nan.kang@nwpu.edu.cn (N. KANG)
(Lab, website): ***http://www.msmp.eu/***

Short description of possible research topics for a PhD:

Due to the high cooling rate of laser additive manufacturing (LAM) process, the metastable phase could be observed in a variety of alloys, for example, martensitic, metallic glass, quasicrystal etc. Those metastable phase is *in-situ* formed during laser melting process, which leads to a special interface properties between the stable and metastable phases (see in Fig. 1). In this thesis, the strengthen mechanism of metastable phase in LAM processed aluminum alloys will be investigated with focus on the synergistic effect. The XRD, SEM, EBSD, TEM and tensile/wear tests will be employed to characterize the microstructural and mechanical properties. A part of this work will be performed at Texas A&MUniversity.

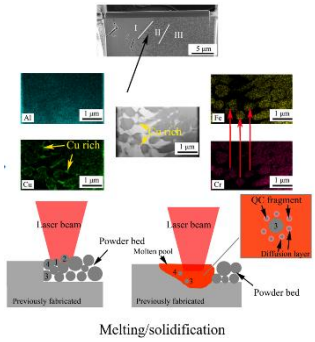


Fig. 1 Quasicrystal reinforced α-Al composite

Required background of the student:
1. Candidates should have a master degree in materials science or mechanical engineering;
2. A background in additive manufacturing, laser materials processing, and materials characterization (XRD, SEM, EBSD, TEM) will be a clear advantage;
3. Candidates should be able to work in a multidisciplinary environment and be fluent in English (both oral and written);

A list of 5(max.) representative publications of the group:
(1) N. Kang, M. El Mansori, X. Lin, F. Guittonneau, H.L. Liao, W.D. Huang, C. Coddet, Composites Part B: Engineering, 155 (2018) 382-390.
(2) N. Kang, M. El Mansori, F. Guittonneau, H. Liao, Y. Fu, E. Aubry, Applied Surface Science, 455 (2018) 736-741.
(3) N. Kang, M. El Mansori, N. Coniglio, C. Coddet, Procedia Manufacturing, 26 (2018) 1034-1040.
(4) N. Kang, H. Yuan, P. Coddet, Z. Ren, C. Bernage, H. Liao, C. Coddet, Materials Science and Engineering: C, 70 (2017) 405-407.
(5) N. Kang, W. Ma, L. Heraud, M. El Mansori, F. Li, M. Liu, H. Liao, Additive Manufacturing, 22 (2018) 104-110.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering, Numerical Methods,Applied Mathematics

Title:Topology Optimization of Additive Manufactured Parts including fatigue behavior

ParisTech School: Arts et Métiers ParisTech

Advisors:
Pr. Véronique FAVIER(veronique.favier@ensam.eu) http://pimm.paris.ensam.fr/en/user/762
Dr. Imade KOUTIRI (imade.koutiri@ensam.eu) http://pimm.paris.ensam.fr/en/user/784
Dr. Eric MONTEIRO (eric.monteiro@ensam.eu) http://pimm.paris.ensam.fr/en/user/767

Short description of possible research topics for a PhD:
In additive manufacturing processes, parts are manufactured layerby layer. Such technics allow the creation of complex structural designsthat other classical processes cannot produce.Efficient numerical tools to generate automatically optimal structure satisfying some requirements are provided by topological optimization methods. However, standard topological optimization formulations for light weighting produce designs with stress concentrations and singularities that cause a reduction in fatigue life. The proposed work deals with the development of a new numerical tool to design lightweight but also fatigue-constrained topologically optimized structures for additive manufacturing. The prediction of this new tool will be compared to some experimental results generated during the thesis.

Required background of the student:
The candidate should have a strong background in Mechanical Engineering, Materials Science and Engineering or Numerical Methods. Although prior knowledge of the French language is not mandatory, spoken and written English proficiency is needed.

A list of 5(max.) representative publications of the group: (Related to the research topic)
N. Torabian, V. Favier, J. Dirrenberger, F. Adamski, S. Ziaei-Rad, S., N. Ranc, Correlation of the high and very high cycle fatigue response of ferrite based steels with strain rate-temperature conditions, Acta Materialia, 134, 40-52, 2017.

I. Koutiri, E. Pessard, P. Peyre, O. Amlou, T. DeTerris, Influence of SLM process parameters on the surface finish, porosity rate and fatigue behavior of as-built Inconel 625 parts, Journal of Materials Processing Technology 255, 536-546, 2018.

E. Monteiro, H.-B. Ly, G. Regnier, M. Dal, On the factors affecting porosity dissolution in Selective Laser Sintering Process, AIP Conference Proceedings 1960, 120014, 2018.

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

Subfield: Materials engineering, metallurgy, mechanical engineering

Title:Architectured metallic sheets through localized laser processing

ParisTech School: Arts et Métiers, Paris campus

Advisor(s) Name: Dr. Justin DIRRENBERGER
Advisor(s) Email:justin.dirrenberger@ensam.eu
(Lab, website):PIMM Laboratory, http://pimm.ensam.eu/en and http://dirrenberger.net

Short description of possible research topics for a PhD: Architectured materials are an emerging class of advanced materials that bring new possibilities in terms of functional properties, filling gaps in material performance maps. Localized processing methods appear as natural candidates for developing such materials.In the context of the SCOLASTIC project aiming at developing architectured metallic materials through computational optimization and localized laser processing, we intend to investigate the localized heat treatment of ultra-high strength dual-phase and martensitic steel sheets for applications in the automotive industry. The forming of components in the automotive industry requires metal sheets to be thinner in order to reduce the mass of cars, thus bringing new challenges for steel producers. Although dual-phase steels comply with such ambitions since they exhibit higher elastic strength, their formability drops when considering high strength grades. Localized laser treatment can induce martensite tempering, hence enabling the possibility to adjust locally the yield strength/ductility trade-off.The approach developed can result in enhanced formability through processes based on plastic deformation, such as deep-drawing. Optimized patterns could also enhance the overall fatigue and fracture behavior.

Required background of the student: metallurgy, computational methods, engineering, materials science, applied mathematics, physics, or any other relevant field.

A list of 5(max.) representative publications of the group:

- Yang, S., Dirrenberger, J., Monteiro, E., & Ranc, N. (2018). Representative volume element size determination for viscoplastic properties in polycrystalline materials. International Journal of Solids and Structures.
- Torabian, N., Favier, V., Dirrenberger, J., Adamski, F., Ziaei-Rad, S., & Ranc, N. (2017). Correlation of the high and very high cycle fatigue response of ferrite based steels with strain rate-temperature conditions. Acta Materialia, 134, 40-52.
- Torabian, N., Favier, V., Ziaei-Rad, S., Dirrenberger, J., Adamski, F., & Ranc, N. (2016). Thermal response of DP600 dual-phase steel under ultrasonic fatigue loading. Materials Science and Engineering: A, 677, 97-105.
- Dirrenberger, J., Forest, S., & Jeulin, D. (2013). Effective elastic properties of auxetic microstructures: anisotropy and structural applications. International Journal of Mechanics and Materials in Design, 9(1), 21-33.
- Dirrenberger, J., Forest, S., & Jeulin, D. (2012). Elastoplasticity of auxetic materials. Computational Materials Science, 64, 57-61.

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering, Computational mechanics, Engineering design

Title:Computational design and optimization of architectured materials

ParisTech School: Arts et Métiers, Paris campus

Advisor(s) Name: Dr. Justin DIRRENBERGER
Advisor(s) Email:justin.dirrenberger@ensam.eu
(Lab, website):PIMM Laboratory, http://pimm.ensam.eu/en and http://dirrenberger.net

Short description of possible research topics for a PhD: Architectured materials are an emerging class of advanced materials that bring new possibilities in terms of functional and structural properties. Their improved specific properties are due to a thoughtful topological design. In the context of a project aiming at developing additive manufacturing for architectured materials, we intend to investigate lightweight materials with the ability to deform with a large amplitude in the elastic domain.The goal of the present project is to perform a parametric study for optimizing the effective (homogenized) behaviour of an auxetic (negative Poisson's ratio) periodic cell, obtained through additive manufacturing (AM), which is also well-studied in the literature, and seems a rather good candidate regarding the set of requirements defined, e.g. crashworthiness, acoustic damping, actuation (cf. Fig.1). Various geometric parameters will be considered in this computational experiment study, using FEA. Effective properties for each configuration will be obtained through computational homogenization. A finite deformation anisotropic thermo-elastoplastic framework will be adopted in order to account for material and geometric non-linearities.

Fig.1: auxetic actuated wingbox (left) and AM optimized parts (Airbus, right)

Required background of the student: computational mechanics, engineering, materials science, metallurgy, applied mathematics, physics, or any other relevant field.

A list of 5(max.) representative publications of the group:

- Wang, Z. P., Poh, L. H., Dirrenberger, J., Zhu, Y., & Forest, S. (2017). Isogeometric shape optimization of smoothed petal auxetic structures via computational periodic homogenization. Computer Methods in Applied Mechanics and Engineering, 323, 250-271.
- Auffray, N., Dirrenberger, J., & Rosi, G. (2015). A complete description of bi-dimensional anisotropic strain-gradient elasticity. International Journal of Solids and Structures, 69, 195-206.
- Dirrenberger, J., Forest, S., & Jeulin, D. (2013). Effective elastic properties of auxetic microstructures: anisotropy and structural applications. Int. Journal of Mechanics and Materials in Design, 9(1), 21-33.
- Dirrenberger, J., Forest, S., & Jeulin, D. (2012). Elastoplasticity of auxetic materials. Computational Materials Science, 64, 57-61.
- Dirrenberger, J., Forest, S., Jeulin, D., & Colin, C. (2011). Homogenization of periodic auxetic materials. Procedia Engineering, 10, 1847-1852.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Industrial Engineering

ParisTech School: Metz campus

Title:Design and development of a process family planning prototype system

Advisor(s): Prof. Ali SIADAT, Centre Arts et Métiers ParisTech de Metz, France
Prof. Linda ZHANG, IESEG School of Management (LEM-CNRS),France,
(https://www.ieseg.fr/en/faculty-and-research/professor/?id=1776)

Short description of possible research topics for a PhD:
This project is aimed at designing and developing a prototype system to plan production processes for product families (i.e., process family planning).

In the recent past, manufacturing firms worldwide have been pursuing mass customization in delivering families of customized products at affordable costs. Process family planning is put forward to help firms effectively produce product families while reusing proven manufacturing knowledge and available facilities.It entails the planning of production processes for product variants based on a process platform of the product family.In accordance with the product complexities, production processes are complex and difficult to plan manually. In this regard, it is necessary to design and develop computer systems to support process family planning automation. There are several important issues to be addressed in designing and developing a process family planning system, including the modeling of process family planning from both the static and dynamic perspectives, the design of system components and their interactions, and the development of a prototype.

Required background of the student: Industrial Engineering, Computer Information Systems, Computer Programming

A list of 5(max.) representative publications of the group:

1. **Zhang, L.** and Jiao, J., A graph rewriting system for process platform planning, *Decision Support Systems*, 2013, 54(2), 1174-1191.
2. **Zhang, L.,** Xu, Q.,and Helo, P., A knowledge-based system for process family planning, *Journal of Manufacturing Technology Management*, 2013, 24(2), 174-196.
3. **Zhang, L.,** Xu, Q., and Helo, P., A methodology integrating Petri nets and knowledge-based systems to support process family planning, *International Journal of Production Research*, 2012, 50(12), 3192-3210.
4. *K. U. ZAMAN, A. SIADAT, M. RIVETTE, A. BAQAI, L. QIAO, «Integrated product-process design to suggest appropriate manufacturing technology: a review", International Journal of Advanced Manufacturing Technology, 2017.*
5. *Q. XIA, A. ETIENNE, J.-Y. DANTAN, A. SIADAT, «Reconfigurable machining process planning for part variety in new manufacturing paradigms: Definitions, models and framework", Computers and Industrial Engineering, 2018*

Research Topic for the ParisTech/CSC PhD Program

Subfield: Industrial Engineering

ParisTech School: Metz campus

Title: Solution space modeling for process platform-based production configuration

Advisor(s): Prof. Ali SIADAT, Centre Arts et Métiers ParisTech de Metz, France
Prof. Linda ZHANG, IESEG School of Management (LEM-CNRS),France,
(https://www.ieseg.fr/en/faculty-and-research/professor/?id=1776)

Short description of possible research topics for a PhD:
This project is aimed at modeling the solution space of process platform-based production configuration to ease mass customization.
In the recent past, manufacturing firms worldwide have been pursuing mass customization in delivering families of customized products at affordable costs. Process platform-based production configuration is put forward to help firms effectively produce product families while reusing proven manufacturing knowledge and available facilities. In relation to a product family, a process platformis underpinned by a generic product-process structure. Production configuration entails the process of configuring production processes for a new family member based on the process platform. Its solution space is discrete and combinatorial in nature. Moreover, in light of the product complexities, it involves diverse constraints from different aspects, including operations, operations precedence, and routings. Thus, it is necessary to develop mathematical models for modeling production configuration solution spaces bounded by multiple constraints from the three different aspects, in attempting to facilitate configuration optimization.

Required background of the student: Mathematics, Industrial Engineering, Computer Science, Mathematical Programming.

A list of 5(max.) representative publications of the group:

1. **Zhang, L.** and Jiao, J., A graph rewriting system for process platform planning, *Decision Support Systems*, 2013, 54(2), 1174-1191.
2. **Zhang, L.,** Xu, Q., Yu, Y., and Jiao, J., Domain-based production configuration with constraint satisfaction, *International Journal of Production Research*, 2012, 50(24), 7149-7166.
3. **Zhang, L.,** Xu, Q., and Helo, P., A methodology integrating Petri nets and knowledge-based systems to support process family planning, *International Journal of Production Research*, 2012, 50(12), 3192-3210.
4. *Q. XIA, A. ETIENNE, J.-Y. DANTAN, A. SIADAT, «Reconfigurable machining process planning for part variety in new manufacturing paradigms: Definitions, models and framework", Computers and Industrial Engineering, 2018*
5. *Mehrdad MOHAMMADI, Reza TAVAKKOLI-MOGHADDAM, Ali SIADAT, Jean-Yves DANTAN, Yaser RAHIMI, «A bi-objective robust inspection planning model in a multi-stage serial production system», International Journal of Production Research, 2017*

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Materials Science, Mechanics, Fluids

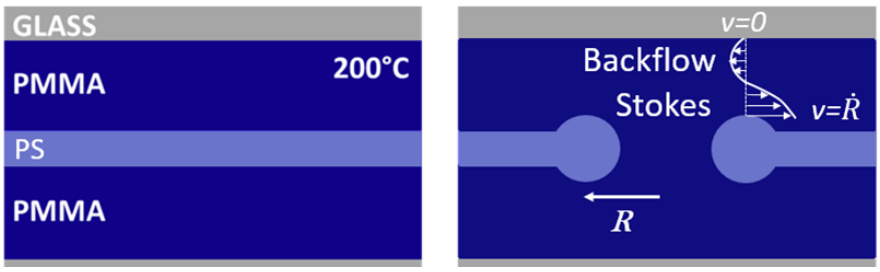
Subfield: Polymer Science (ideally, more physics and engineering than chemistry oriented)

Title:*Dewetting dynamics of a polymer thin film embedded in an immiscible polymer matrix*

ParisTech School: ENSAM

Advisor(s) Name: G. Miquelard-Garnier & C. Sollogoub
Advisor(s) Email: ***quillaume.miquelardgarnier@lecnam.net; cyrille.sollogoub@lecnam.net***
(Lab, website):Laboratoire PIMM http://pimm.ensam.eu/; http://pimm.ensam.eu/en/user/156

Short description of possible research topics for a PhD: When a glassy thin polymer film is placed on top of a substrate with which it has no affinity and heated above its glass transition temperature, it will spontaneously dewet. Both nucleation mechanisms and dewetting kinetics have been widely studied over the last 25 years.
We recently developed in the lab an experiment where the thin film is actually embedded in two thicker layers of an immiscible matrix. We showed that the dynamics is different from the simpler case described previously. Notably, the viscous dissipation occurs in the surrounding matrix and extends over distances several order of magnitude higher than the film thickness.
In the proposed research we would like to further explore this system under many aspects, such as the asymmetric case where the outer layers have different thicknesses. The role of the interfacial tension will also be thoroughly characterized with the use of well-defined copolymers placed at the interfaces. Finally, the finite-size effect which plays a role in the viscous dissipation balancing the capillary forces in our model will be investigated.
This study shall lead to a better knowledge of the dewetting dynamics of polymeric multilayer systems, which is of interest for applications in both thermoplastics processing but also for microfluidics.This work is part of an-going and successful collaboration with academic and industrial partners.



Schematic of the experiment illustrating the proposed dewetting mechanism

Required background of the student: Polymer Science or Soft Matter Physics or Fluid Mechanics

A list of 5(max.) representative publications of the group:

[1] Y. Zhu, A. Bironeau, F. Restagno, C. Sollogoub, G. Miquelard-Garnier, *Polymer*, **2016**, 90, 156
[2] M. Chebil, J.D. McGraw, T. Salez, C. Sollogoub, G. Miquelard-Garnier, *Soft Matter*, **2018**, 14, 6256
[3] A. Bironeau, T. Salez, G. Miquelard-Garnier, C. Sollogoub, *Macromolecules*, **2017**, 50, 4064
[4] G. Miquelard-Garnier, S. Roland, *European Polymer Journal*, **2016**, 84, 111
[5] J. Feng, Z. Zhang, A. Bironeau, A. Guinault, G. Miquelard-Garnier, C. Sollogoub, A. Olah, E. Baer, *Polymer*, **2018**, 143, 19

Research Topic for the ParisTech/CSC PhD Program

Subfield: Chemistry, Physical Chemistry, Materials Science, Plasma processing

ParisTech School: Chimie ParisTech (Paris, France ; https://www.chimie-paristech.fr) / Institut Pierre-Gilles de Gennes (Paris, France ; http://www.institut-pgg.com)

Title: Smart functional material

Advisor(s): Vincent SEMETEY(vincent.semetey@chimie-paristech.fr) and Cedric GUYON (cedric.guyon@chimie-paristech.fr)

Short description of possible research topics for a PhD: (10 lines in English + optional figure)
Our groups are involved in different aspects of the interface between material chemistry and physical chemistry from fundamental to applied research. Smart functional surfaces are increasingly important in many fields such as in medicine (e.g. implantable medical devices…), aircrafts or automotive industry…. In this project, we propose to design and create innovative smart surfaces with controlled surface properties (with specific physical and chemical characteristics) tacking advantage atmospheric pressure plasma process.
Our main interest is the synthesis of new polymeric or hybrid polymer/mineral material obtained by radical polymerization through both rational design and combinatorial chemistry. Different architectures will be investigated for their ability to modify surface properties (plastics, metals). The synthesized thin films and coatings will analyzed in detail with respect to their chemical composition, structure and properties in order to ensure the suitability for the desired functionality and subsequently create smart functional materials for a broad range of applications (e.g. biomedical ..).

Required background of the student: (Which should be the main field of study of the applicant before applying)
Chemistry, Chemical Engineering, Organic Chemistry or Polymer Chemistry.

2-3 representative publications of the group: (Related to the research topic)

[1] "Deposition of Organic Coatings at Atmospheric Pressure from Liquid Precursors" Tatoulian M., Arefi-Khonsari F., Borra J.P. *Plasma Process. Polym*. **2007**, *4*, 360-369.
[2] "Facile and Efficient Control of Bioadhesion on Poly(dimethylsiloxane) by using a Biomimetic Approach" Mussard W., Kebir N., Kriegel I., Estève M., Semetey V., *Angewandte Chemie Int. Ed. Engl.* **2011**, *50*, 10871-10874.
[3]"A Versatile Approach to Design on Demand Self-Assembled Monlayer on Glass using Thiolene Chemistry" Oberleitner B., Dellinger A., Déforet M., Galtayries A., Castanet A.-S., Semetey V. *Chemical Communications* **2013**, *49*, 1615 - 1617.
[4]"Preventing biofilm formation and associated occlusion by biomimetic glycocalyx-like polymer in central venous catheters" Chauhan A., Bernardin A., Mussard W., Kriegel I., Estève M., Ghigo J. M., Beloin C., Semetey V. *The Journal of Infectious Diseases.* **2014**, *210*, 1347-56.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below):
2. Chemistry, Physical Chemistry and Chemical Engineering
4. Energy, Processes.
8. Materials Science, Mechanics, Fluids

Subfield: Chemistry

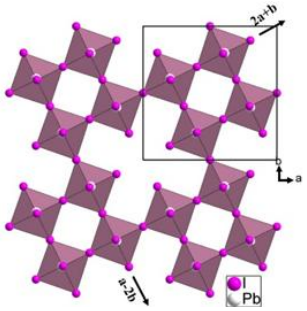
***Title*:*Development of new hybrid perovskites for advanced applications*.**

ParisTech School:Chimie-Paristech

Advisor(s) Name: Dr. Thierry PAUPORTÉ
Advisor(s) Email: thierry.pauporte@chimie-paristech.fr

(Lab, website): Institut de Recherche de Chimie-Paris, 11 rue P. et M. Curie 75005 Paris, France. http://www.ircp.cnrs.fr/spip.php?article137

Short description of possible research topics for a PhD:
Recently, hybrid halogen perovskites (HPs) have emerged as fascinating materials and highly versatile semiconductors. These compounds can be prepared as 3D materials of ABX_3general formulae which composition can be varied over some extend. This ensures the possible tuning of their optoelectronic properties. Their properties make them attractivephotoactive materials for photodetectors, solar cells, light-emitting diodes, and lasers. Recently, we have discovered a new family of 3D perovskite materials in which BX^+groups are partly replaced by a monovalent organic cation (see Ref-1 ° and Figure). Their advantages are the possibility of stabilizing certain phases, to go beyond the Goldschmidt tolerance factor and to get superior properties: high stability, finely tunable opto-electronic properties while keeping the 3D structure and a high electric conductivity.
The aim of the Ph.D will be to investigate this new family of materials. The B(II) cation will be varied (Pb, Sn, Ge). Various large replacement organic cations will be investigated. These new perovskites will be prepared as thin films. They will be designed and their properties will be tuned to integrate them in efficient and stable perovskite solar cells (PSC) and photodetectors. The work will include the full characterization of the HP layers, the fabrication of the solar cells and photodetectors as well as the characterizations of the corresponding devices.



Required background of the student: Material science, Chemistry, if possible Physics of semiconductors, photovoltaics.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1°) A. Leblanc, N. Mercier, M. Allain, J. Dittmer, V. Fernandez, T. Pauporté, *Lead and iodide deficient MAPI, d-MAPI: the bridge between 2D and 3D hybrid perovskites*.Angew.Chem. Int. Ed., 56 (2017) 16067 –16072.
2°) Thierry Pauporté, "Synthesis of ZnO Nanostructures for Solar Cells- A Focus on Dye-Sensitized and Perovskite Solar Cells."In "*The Future of Semiconductor Oxides in Next-Generation Solar Cells*" (2017) Chap. 1, pp.3-43.
3°) M. Ulfa, P. Wang, J. Zhang, J. Liu, W. Daney de Marcillac, L. Coolen, S. Peralta, T. Pauporté, *Charge Injection and Electrical Response in Low Temperature SnO_2-Based Efficient Perovskite Solar Cells*.ACS Appl. Mater. Interfaces, (2018) DOI: 10.1021/acsami.8b10979.1.
4°) M. Ulfa, T. Zhu, F. Goubard , Th. Pauporté, *Molecular versus Polymeric Hole Transporting Materials for Perovskite Solar Cell Application*.J. Mater. Chem. A., 6 (2018) 13350 - 13358
5°) D. Pitarch-Tena, T.T. Ngo, M. Vallés-Pelarda, Th. Pauporté, I. Mora-Seró, *Impedance Spectroscopy Measurements in Perovskite Solar Cells. Device Stability During the Measurement and Noise Reduction*.ACS Energy Lett., 3 (2018) 1044−1048.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Chemistry, Physical Chemistry

ParisTech School: Chimie ParisTech (http://www.chimie-paristech.fr/), Paris, France

Title: Bioactive surfaces

Advisor(s): Vincent SEMETEY (vincent.semetey@chimie-paristech.fr) and Sylvie COSCOY (sylvie.coscoy@curie.fr)

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Implantable medical devices are increasingly important in the practice of modern medicine. Unfortunately, almost all medical devices suffer to a different extent from adverse reactions, including inflammation, fibrosis, thrombosis and infection due to protein adsorption or cell adhesion. Here we propose to design new biofunctional polymers and engineer innovative smart surfaces with controlled surface property (physical and chemical characteristics) to kill bacteria or reduce protein adsorption and cell interactions and subsequently improve implant biocompatibility.
Our main interest is the synthesis of new polymers obtained by radical polymerization through both rational design and combinatorial chemistry using several moieties (e.g. quaternary ammonium salts, zwiterionic or oligoethylene glycol derivatives, N-Isopropylacrylamide…). Different polymeric architectures will be investigated for their ability to modify surface properties (plastics, metals). We will as well take advantage of two-photon photopolymerisation to generate 3D microtopographies to obtain responsive materials.
This work will be done in collaboration with Institut Curie for the biological evaluation of the generated materials.

Required background of the student: (Which should be the main field of study of the applicant before applying)
Chemistry, Chemical Engineering, ideally with good knowledge and skill in organic and polymer chemistry or some knowledge in biochemistry.

A list of 5 (max.) representative publications of the group: (Related to the research topic)
[1] Mussard W., Kebir N., Kriegel I., Estève M., Semetey V., *Angewandte Chemie Int. Ed. Engl.* **2011**, *50*, 10871-10874.
[2] Oberleitner B., Dellinger A., Déforet M., Galtayries A., Castanet A.-S., Semetey V. *Chemical Communications* **2013**, *49*, 1615-1617.
[3] Chauhan A., Bernardin A., Mussard W., Kriegel I., Estève M., Ghigo J. M., Beloin C., Semetey V. *The Journal of Infectious Diseases.* **2014**, *210*, 1347-56.
[4] Kebir N., Kriegel I., Esteve M., Semetey V. *Applied Surface Science* **2016**, *360*, 866-874.
[5] Coscoy S., Baiz S., Octon J., Rhoné B., Perquis L., Tseng Q., Amblard F., Semetey V. *Biointerphases*. **2018**,13, doi: 10.1116/1.5024601.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Chemistry, Physical Chemistry and Chemical Engineering, Life Science and Engineering for Agriculture, Food and the Environment

Subfield: Electrochemistry, Bio analytical chemistry

*Title:***New biocompatible surface-attached hydrogel immobilization matrix for improved biosensors**

ParisTech School: Chimie ParisTech

Advisor(s) Name: FethiBediou, Cyrine Slim, Sophie Griveau
Advisor(s) Email:**fethi.bedioui@chimie-paristech.fr**
(Lab, website):http://www.upcgi.cnrs.fr/spip.php?rubrique9

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Electrochemical biosensors are integrated devices transducing the biological element-target recognition events into a detectable electrochemical signals. The development and interest for such sensors are their high selectivity towards the target analyte thanks to the biological sensing element. Biological sensing elements are of diverse nature: enzymes, aptamers, antibodies, cell…To get ergonomic and compact devices, the biological receptors are immobilized / integrate at the electrochemical interface. Upon target binding, the modification of the electrochemical signal of the redox reporter is directly related to the concentration of the target species. Electrochemical biosensors have attracted much attention owing to their simple configurations, low cost, multiplexed detection capabilities, high sensitivity and selectivity, as well as ease of miniaturization for portable point-of-care diagnostics and environmental monitoring. Engineering the bioelectrochemical sensing interface is crucial for improving the sensitivity and stability of electrochemical biosensors.

The immobilization procedure of the bioreceptor is one of the technological locks affecting the biosensors performance. It must assure both the preservation of its affinity towards the target and its stability. In this regard, several physical and chemical methods have been reported over the years to improve the bioreceptor immobilization. Hydrogels appear as attractive materials due to their three-dimensional hydrophilic networks and their high-water content. They present a lot of advantages thanks to their biocompatibility, highly deformability and adaptability while providing versatile, flexible and straightforward chemistry. This results in, promoting the bioreceptor long-term stability and providing suitable scaffold for trapping.The objectives of the project SATELIT is to combine electrochemistry and polymer expertise fields, to conceive tunable, sensitive and miniaturized electrochemical biosensors *via* the design of smart polymeric interfaces..

Surface-attached biocompatible hydrogel thin films with well-controlled chemistry and tailored architecture will be suitably used as immobilization matrix of biomolecules for molecular recognition of the target. From biomolecules, aptamers constitute an attractive alternative to antibodies due to their high affinity and their excellent specificity for a target or a family of selected targets. It is also possible to functionalize them with specific chemical functions and/or with tag to label the aptamers, for their further immobilization and/or for their analysis. They can be handled at room temperature, and are easily regenerated after denaturation, allowing their re-use which is interesting for the regeneration aspect of the biosensor. Immobilizing aptamers onto surface-attached hydrogel thin films notably by covalent attachment could provide a biocompatible shelter, while allowing the detection of small molecules. The density of immobilized aptamers that will affect the sensitivity of the sensor will be controlled thanks to hydrogel controlled chemistry which allow to developed sensor for trace and ultra-trace analytes detection. Incorporation of nanostructured metallic materials inside the hydrogel network and its role to improve biosensing characteristics will be explored. Within a constant

miniaturization effort, we will tend towards the transposition of this work, towards microfluidic electrochemical biosensors on real samples due to their miniature, portable and low-cost systems as well as high through put and automation. The integration of electrochemical sensors into microfluidic formats with the incorporation of unique materials for detection will be explored in this project. The development of these systems would lead to significant advantages compared to the current analytic systems, in terms of simplicity, speediness, cost, and automation.

Required background of the student: (Which should be the main field of study of the applicant before applying)

Physical chemistry, ideally background in basic electrochemistry

A list of 5(max.) representative publications of the group: (Related to the research topic)

Quinton, D., Girard, A., Thi Kim, L. T., Raimbault, V., Griscom, L., Razan, F., Bedioui, F. (2011).On-chip multi-electrochemical sensor array platform for simultaneous screening of nitric oxide and peroxynitrite. Lab on a Chip, 11(7), 1342–1350

Griveau, S., &Bedioui, F. (2013).Electroanalytical methodologies for the detection of S-nitrosothiols in biological fluids. The Analyst, 138(18), 5173–81

Ramirez-Garcia, G., Martinez-Alfaro, M., Gutierrez-Granados, S., Alatorre-Ordaz, A., Griveau, S., &Bedioui, F. (2015). Electrochemical assessment of possible melatonin effect on nitric oxide production from kidneys of sub-acute lead treated rats. ElectrochimicaActa, 166, 88–92

Slim, C., Ratajovà, E., Griveau, S., Kanoufi, F., Ferraro, D., Perrérard, C., Bedioui, F. (2015). Two-step local functionalization of fluoropolymerDyneon THV microfluidic materials by scanning electrochemical microscopy combined to click reaction. Electrochemistry Communications, 60, 5–8

P.M. Olmos Moya, M. Martínez Alfaro, R. Kazemi, M. A. Alpuche-Avilés, S.Griveau, F. Bedioui, and S. Gutiérrez Granados (2017) Simultaneous Electrochemical Speciation of Oxidized and Reduced Glutathione. Redox Profiling of Oxidative Stress in Biological Fluids with a Modified Carbon Electrode, Anal Chem 89, 10726-10733

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** 2. Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry

Title: Ruthenium Complexes against Cancer

ParisTech School: Chimie ParisTech

Advisor(s) Name: Gilles Gasser
Advisor(s) Email:gilles.gasser@chimieparistech.psl.eu
(Lab, website):www.gassergroup.com

Short description of possible research topics for a PhD:
Currently, cisplatin and its other Pt(II) derivatives are involved in more than 50% of chemotherapeutic treatments against cancer. However, despite these impressive numbers, cisplatin still suffers from several important drawbacks which include severe side-effects. *There is therefore a need for novel,metal-based,anticancer drug candidates*.The phenomenal success of cisplatin has boosted the research directed at novel metal-based anticancer drugs beside Pt complexes. Among the potential metal-based candidates, Ru complexes have emerged as leading players by showing extremely promising results, with three such compounds in clinical trial. Our group has notably shown, over recent years, that Ru(II) polypyridine complexes are extremely active against cancer both *in vitro* and *in vivo*. In this project, we plan to undertake a structure-activity study to unveil novel lead compounds against cancer.
The applicant will have to first synthesize and characterize (NMR, MS, X-ray crystallography, electrochemistry) new metal compounds. She/he will then have to assess the stability in biological media (i.e. human plasma) of these compounds as well as perform metabolic studies to understand the fate of the compounds in the presence of different enzymes. The biological experiments will then be undertaken in our laboratory.

Required background of the student: The applicant should have a sound knowledge (theoretical and practical) in both inorganic and organic chemistry and be proficient with analytical techniques such as NMR and MS. The applicant must be fluent in English since it is the language spoken in the Gasser group. Practical knowledge in biology would be an asset.

A list of 5(max.) representative publications of the group:

1. **Monomeric and Dimeric Coordinatively Saturated and Substitutionally Inert Ru(II) Polypyridyl Complexes as Anticancer Drug Candidates** A. Notaro and **G. Gasser**,*****Chem. Soc. Rev*,**2017**, *46*, 7317-7337.
2. **The Medicinal Chemistry of Ferrocene and its Derivatives**M. Patra* and **G. Gasser**,*****Nat. Rev. Chem.*,**2017**, *1*, 0066.
3. **Molecular and Cellular Characterization of the Biological Effects of Ruthenium(II) Complexes Incorporating 2-Pyridyl-2-Pyrimidine-4-Carboxylic Acid**
   V. Pierroz, T. Joshi, A. Leonidova, C. Mari, J. Schur, I. Ott, L. Spiccia,* S. Ferrari* and **G. Gasser,***J. Am. Chem. Soc*., **2012**, *134*, 20376-20387.
4. **Bis(dipyridophenazine)(2-(2′-pyridyl)pyrimidine-4-carboxylic acid)ruthenium(II) hexafluorophosphate: A Lesson in Stubbornness**

T. Joshi,* V. Pierroz, S. Ferrari and **G. Gasser,***ChemMedChem*,**2014**, *9*, 1419-1427.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Chemistry, Physical Chemistry and Chemical Engineering

Subfield:Energy, Processes

Title: Electrochemical CO_2 Mineralization and H_2Production

ParisTech School: Chimie ParisTech

Advisor(s) Name:
LAIR, virginie.lair@chimie-paristech.fr
http://ircp.cnrs.fr/spip.php?article212
LAZERGES, mathieu-lazerges@ens.chimie-paristech.fr
http://www.upcgi.cnrs.fr/spip.php?article33

Short description of possible research topics for a PhD:
Currently, the challenge of reducing greenhouse gas emissions of CO_2 is such that different routes are envisaged, particularly for its valorization. Thus, there are three main categories for the recovery of CO2: the direct route (without transformation, carbon dioxide is used in industry such as petrochemicals), biological recovery (as a nutrient for photosynthetic organisms, especially algae) or use as a raw material after processing.
The objective of this project is to propose a pathway for electrochemical CO_2 mineralization, by referring to a state of the art on existing and future carbon dioxide recovery and storage processes.
CO_2 mineralization is a natural geological SLOW process that involves reacting CO_2 with abundant oxides (magnesium, calcium) to obtain stable and inert carbonates. The idea is to use the contribution of electrochemistry to provide the energy needed to increase the reaction rate.
The originality of the CO_2 electrochemical mineralization project is that it proposes a process to recycle and use the formed hydrogen and to valorize building materials or to use inexpensive alkaline ores. The energy cost of the process will be at the heart of the subject and the developed prototype will have to consist of non-membrane separators, whose cost and electrical resistance are lower and the service life longer than the membrane separators.

Required background of the student: (Which should be the main field of study of the applicant before applying)
electrochemistry

A list of 5(max.) representative publications of the group: (Related to the research topic)
•*V. Lairet al.*, Hydrogen Energy, **2016**, DOI: 10.1016/j.ijhydene.2016.09.118.
•*V. Lair et al.*, International Journal of Hydrogen Energy, **2016**, v41, p18721-18731.
•*V. Lairet al.*, International Journal of Hydrogen Energy, **2015**, v40, p11378-11384.
•*V. Lairet al.*, Frontiers Energy Research, **2015**, DOI: 10.3389/fenrg.2015.00043.
• V. Lair et al., Electrochimica Acta, **2015**, v184, p295-300.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): 1 - Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry, Physical Chemistry, Materials Science

ParisTech School: Chimie ParisTech (Paris, France ; https://www.chimie-paristech.fr) / Institut Pierre-Gilles de Gennes (Paris, France ; http://www.institut-pgg.com)

Title: Functionalization of polymers by atmospheric pressure plasma in order to improve their adhesive properties

Advisor(s): Dr Cedric GUYON (cedric.guyon@chimieparistech.psl.eu) / Pr Michael TATOULIAN

Short description of possible research topics for a PhD: (

Most rubber compounds like EPDM and thermoplastic elastomers have very low surface energies. The low surface energy results in difficulty in bonding or coating materials onto these surfaces. Currently, the bonding process is long and complex to achieve adhesion specificities (abrasion, dip coating…). In fact, the incorporation of polar groups such as hydroxyls or amines groups is a preponderant factor for adhesion, thus promoting chemical anchoring. It is often demonstrated that the adhesion strength is linearly proportional to the density of plasma grafted groups on the surface of the material without altering the other physicochemical properties. Here we propose to optimize a plasma process at atmospheric pressure in order to be able to functionalize or realize a functional coating on the surfaces of the polymers studied in order to improve their adhesive properties. The polymer surface will be characterized by surface analysis techniques and the titration of functional groups will be realize.

Required background of the student:

Chemistry, Chemical Engineering, Material

Representative publications of the group: (Related to the research topic)

[1] Y. Ladner, F. d'Orlyé, C. Perréard, B. Da Silva, C. Guyon, M. Tatoulian, S. Griveau, F. Bedioui and A. Varenne, "Surface Functionalization by Plasma Treatment and Click Chemistry of a New Family of Fluorinated Polymeric Materials for Microfluidic Chips"; Plasma Process. Polym. (DOI: 10.1002/ppap.201300120) - April 2014.

[2] Da Silva, B., Schelcher, G., Winter, L., Guyon, C., Tabeling, P., Bonn, D. and Tatoulian, M. "Study of the stability and hydrophilicity of plasma-modified microfluidic materials", Plasma Processes and Polymers , 4 OCT 2016, DOI: 10.1002/ppap.201600034.

[3] High density gold nanoparticles immobilized on surface via plasma deposited APTES film for decomposing organic compounds in microchannels ,Xi Rao, Cédric Guyon, Stephanie Ognier, Bradley Da Silva, Chenglin Chu, Michaël Tatoulian, Ali Abou Hassan, Applied Surface Science Volume 439, 1 May 2018, Pages 272-281

Research Topic for the ParisTech/CSC PhD Program

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry

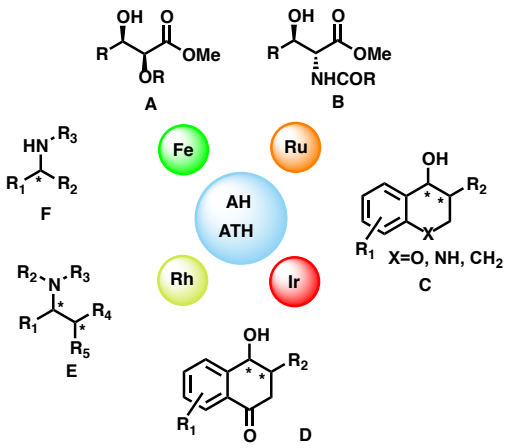
Title: Asymmetric Catalysis toward BioRelevant Architecturally Novel Natural and Unnatural Products

ParisTech School: Chimie ParisTech

Advisor Name: Virginie VIDAL
Advisor Email: virginie.vidal@chimie-paristech.fr
(Lab, website): Institut de Recherche de Chimie Paris (IRCP), CSB2D Team
https://www.chimie-paristech.fr/

Short description of possible research topics for a PhD:

Our group develops new catalytic processes for the synthesis of natural products and targets of biological interest. We have been interested in the development of novel methods for synthetic efficiency and atom and step economical processes using transition metal-catalyzed reactions as they provide a direct and selective way toward the synthesis of highly valuable products. The research program will be dedicated to the development of asymmetric catalytic methods in a context of sustainable development for carbon-carbon and carbon-hydrogen bond forming reactions using asymmetric hydrogenation (AH) or asymmetric hydrogen transfer reactions (ATH) [1] through dynamic kinetic resolution (DKR)[2,4,5] to target scaffolds of biorelevant molecules of medicinal interest such as mirabalin.[3] The PhD research program aims at developing new catalytic asymmetric approaches to address long-standing problems in the synthesis of chiral key intermediates such as A-F to access natural products and pharmaceutical drugs.



Required background of the student: Synthetic Organic Chemistry - Catalysis

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] Ayad, T.; Phansavath, P.; Ratovelomanana-Vidal, V. *Chem. Rec.* **2016,** *16*, 2750.
[2] Review : Echeverria, P.-G.; Ayad, T.; Phansavath, P.; Ratovelomanana-Vidal, V. *Synthesis* **2016**, *48*, 2523.
[3] Echeverria, P.-G.; Prévost, S.; Cornil, J.; Férard, C.; Reymond, S.; Guérinot, A.; Cossy, J.; Ratovelomanana-Vidal, V.; Phansavath, P. *Org. Lett.* **2014**, *16*, 2390.
[4] Zheng, L.-S.; Férard, C.; Phansavath, P.; Ratovelomanana-Vidal, V. *Chem. Commun.* **2018**, *54*, 283.
[5] 0Zheng, L.-S.; Férard, C.; Phansavath, P.; Ratovelomanana-Vidal, V. *Org. Lett* **2018**, *20*, 5107.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Chemistry, Physical Chemistry and Chemical Engineering

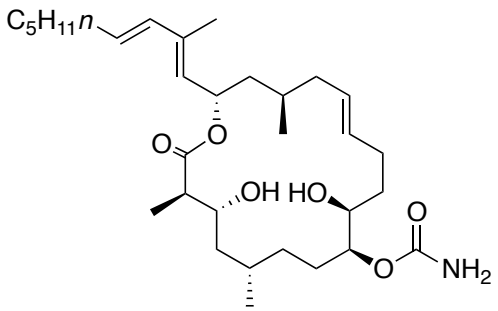
Subfield: Chemistry

Title: Total synthesis of tulearin A and analogues

ParisTech School: Chimie ParisTech

Advisor(s) Name: Phannarath Phansavath
Advisor(s) Email: phannarath.phansavath@chimieparistech.psl.eu
(Lab, website): IRCP, CSB2D team
https://www.chimie-paristech.fr/

Short description of possible research topics for a PhD:
Tulearins constitute a small family of macrolides isolated from a Madagascar sponge of the *Fascaplysinopsis* genus. The potent anti-proliferative activity of Tulearin A against two human leukemia cell lines made it an interesting target and two total synthesis of this compound have been reported. As part of our ongoing research directed toward the synthesis of biologically relevant compounds,[1,2] we propose in this PhD program to develop an efficient total synthesis of Tulearin A and of analogues of the natural product, using new catalytic systems to introduce the various stereogenic centers.[3-5]



Tulearin A

Required background of the student: Synthetic Organic Chemistry, Homogeneous Catalysis

A list of 5(max.) representative publications of the group:
[1] Echeverria, P.-G.; Prévost, S.; Cornil, J.; Férard, C.; Reymond, S.; Guérinot, A.; Cossy, J.; Ratovelomanana-Vidal, V.; Phansavath, P. *Org. Lett.* **2014**, *16*, 2390.
[2] Perez, M.; Echeverria, P.-G.; Martinez-Arripe, E.; Ez Zoubir, M.; Touati, R.; Zhang, Z.; Genet, J.-P. ; Phansavath, P.; Ayad, T.; Ratovelomanana-Vidal, V. *Eur. J. Org. Chem.* **2015**, 5949.
[3] Echeverria, P.-G.; Ayad, T.; Phansavath, P.; Ratovelomanana-Vidal, V. *Synthesis* **2016**, *48*, 2523.
[4] Zheng, L.-S.; Férard, C.; Phansavath, P.; Ratovelomanana-Vidal, V. *Chem. Commun.* **2018**, *54*, 283.
[5] Zheng, L.-S.; Férard, C.; Phansavath, P.; Ratovelomanana-Vidal, V. *Org. Lett* **2018**, *20*, 5107.

Research Topic for the ParisTech/CSC PhD Program

***Field:** 8. Materials Science; 7. Life and Health Science and Technology; 2. Chemistry

Subfield: Physical metallurgy; Biomaterials; Corrosion science

Title:High-performance bioresorbable alloys for cardiovascular implants

ParisTech School:Chimie-paristech, ENSCP, PSL university

Advisor(s) Name: Dr. Philippe VERMAUT; Dr. Fan SUN
Advisor(s) Email: ***philippe.vermaut@chimieparistech.psl.eu; fan.sun@chimieparistech.psl.eu***
(Lab, website): *Equipe de Métallurgie Structurale*

Short description of possible research topics for a PhD:

Metallic stents are commonly used to promote revascularization and maintain patency of plaqued arteries. To mitigate chronic inflammation and late stage thrombosis associated with stainless steel and Co-Cr stents, a new generation of bioresorbable stents is currently being expected. The bioresorbable stents will corrode and be absorbed by the artery after completing their task as vascular scaffolding. However, the outcomes from current biodegradable materials (polymeric, Fe-based, Zn-based and Mg-based) are still far from clinical requirements due to their poor mechanical performances. New insights from metallurgical development on this special type of materials are planned to explore the potentials for an absorbable metallic stent with balanced mechanical and biodegradation characteristics for optimal clinical performance. The host lab has invented the strain-transformable (TRIP/TWIP) conceptual alloys by tailoring the chemistry-microstructure-property relationship in Ti alloys. Its extension to bioresorbable alloying systems will be the key point and of great challenge to this PhD project.During the thesis, experimental works based on our preliminary results are intended to develop and assess systematically new alloy systems forTRIP/TWIP effects and suitablecorrosion behaviors. The thesis will be an important part of the fundamental research of the lab to answer specific scientific questions fromproof-of-concept to mechanism. TRL 5-6 (Technology readiness levels) is expected at the end of the 36/48-month thesis. The work will be directed mainly by Dr. Fan SUN, permanent lecturer-researcher of Chimie-paristech, for the experimental works (alloy design, elaboration, thermo-mechanical processing, metallurgical preparations, electronic microscopes SEM/TEM, in-situ mechanical testing, electrochemical testing), for supervision of scientific quality and for high-impact publications and communications.

Required background of the student:Master ofmetallurgy and metallic materials, experienced in biomaterial characterizations and electronic microscopies SEM/TEM, basic in electrochemistry, excellent English communication and writing, motivated in team-working and project-running.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. Sun, F; Hao, YL; Nowak, S; Gloriant, T; Laheurte, P; Prima, F*; *A thermo-mechanical treatment to improve the superelastic performances of biomedical Ti–26Nb and Ti–20Nb–6Zr (at.%) alloys*, **Journal of the mechanical behavior of biomedical materials**, 4,1864-1872, 2011.
2. Sun, F*; Zhang, JY; Marteleur, M; Gloriant, T; Vermaut, P; Laillé, D; Castany, P; Curfs, C; Jacques, PJ; Prima, F; *Investigation of early stage deformation mechanisms in a metastable β titanium alloy showing combined twinning-induced plasticity and transformation-induced plasticity effects*, **ActaMaterialia**, 61, 6406-6417, 2013.
3. Sun, F; Zhang, JY; Marteleur, M; Brozek, C; Rauch, EF; Veron, M; Vermaut, P; Jacques, PJ; Prima, F*; *A new titanium alloy with a combination of high strength, high strain hardening and improved ductility*, **ScriptaMaterialia**, 94, 17-20, 2015.
4. Sun, F;Vermaut, P;Choudhuri, D;Alam, T;Mantri, SA;Svec, P;Gloriant, T; Jacques, PJ; Banerjee, R*; Prima, F*;*Strengthening strategy for a ductile metastable β-titanium alloy using low-temperature aging*; **Materials Research Letters**, 5, 547-553, 2017.
5. Lilensten, L;Danard, Y;Brozek, C;Mantri; S, Castany; P, Gloriant; T, Vermaut; P, Sun, F*; Banerjee R, Prima F; *On the heterogeneous nature of deformation in a strain-transformable beta metastable Ti-V-Cr-Al alloy*; **ActaMaterialia**, 162, 268-276, 2019

Research Topic for the ParisTech/CSC PhD Program

Subfield: Theoretical and Computational Chemistry

ParisTech School:ChimieParisTech

Title:Development of new double hybridfunctionals for the description of ground and excited state properties

Advisor(s): Carlo Adamo (carlo.adamo@chimie-paristech.fr)
www.chimie-paristech.fr/labos/LECA/Research/site_msc

Short description of possible research topics for a PhD:
The aim of this PhD work is to develop new approaches rooted on Density Functional Theory enabling the correct description of the structural and electronic features at the ground and excited state of complex molecular systems. In particular, it is well known that currently applied DFT based methods, such as global hybrids, are affected by systematic errors related by the use of approximate exchange and correlation functionals. Our recent works have shown how improved numerical performances are obtained with the so-called Double Hybrids functionals, which combinestandard DFT approaches with a perturbative treatment for correlation energy (MP2 term). These new family of functionals is still much less exploited and developed, though results obtained up to now for the description of difficult chemical casesare very encouraging. The aim of this thesis will be to develop new double hybrid functionalsfollowing the ab-initio (i.e. non-parameterized) philosophy of functionals' development we have applied in the past to develop the popular global hybrid PBE0 and more recently double hybrid derivatives, such as the PBE0-DH. The so-constructed functionals will be implemented in the computer code Gaussian (www.gaussian.com), whose prof. Adamo is one of the co-authors, and tested not only on case study (benchmarks) but also on real chemical systems.

Required background of the student: Theoretical and Computational Chemistry, Chemical Physics or Physical Chemistry.

A list of 5(max.) representative publications of the group:
1) I. Y. Zhang, N. Q. Su, E. Brémond, C. Adamo, X. Xu *Doubly hybrid density functional xDH-PBE0 from a parameter-free global hybrid model PBE0*, J. Chem. Phys. 136 (2012) 174103

2) D. Bousquet, E. Brémond, J.C. Sancho-García, I.Ciofini, C. Adamo, *Is There Still Room for Parameter Free Double Hybrids? Performances of PBE0-DH and B2PLYP over Extended Benchmark Sets* J. Chem. Theory Comp. 9 (2013) 3444-3452.

3) E. Brémond, J.C. Sancho-García, Á. J. Pérez-Jiménez, C.Adamo*Double-hybrid Functionals from Adiabatic-Connection: the QIDH model* J. Chem. Phys.141 (2014) 031101

4) E. Brémond, M. Savarese, A.J. Perez-Jimenez, J.C. Sancho-Garcia, C. Adamo *Systematic Improvement of Density Functionals through Parameter-Free Hybridization Schemes* J. Phys. Chem. Lett. 6 (2015) 3540-3545.

5) E.Brémond, I.Ciofini, J.C. Sancho-García, C.Adamo, *Nonempirical Double-Hybrid Functionals: An Effective Tool for Chemists* Acc. Chem. Res. 49 (2016) 1503–1513

Research Topic for the ParisTech/CSC PhD Program

Subfield: Chemistry and Materials Science

ParisTech School: Chimie ParisTech

Title: Tandem Catalysis of Polyureas and Polyurethanes: A New Modular Approach to Polypeptide Analogues

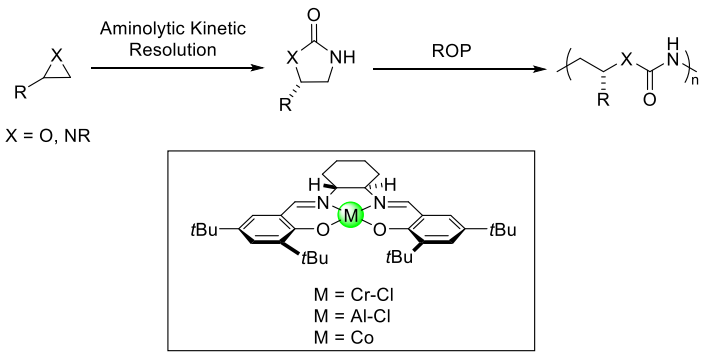
Advisor(s): Dr. Carine Robert (carine.robert@chimie-paristech.fr) / Prof. Christophe Thomas (christophe.thomas@chimie-paristech.fr), http://ircp.cnrs.fr/spip.php?article172

Short description of possible research topics for a PhD:

Tandem catalysis is one of the strategies used by Nature for building macromolecules. Living organisms generally synthesize macromolecules by *in vivo* enzyme-catalyzed chain growth polymerization reactions using activated monomers that have been formed within cells during complex metabolic processes.[1] However, these biological processes rely on highly complex biocatalysts thus limiting their industrial applications.

In the same biomimetic spirit, we want to initiate a research effort to synthesize **biodegradable** polymers[2] via tandem **catalytic transformations**, where "activated" monomers are synthesized from raw materials (in one or more steps) and subsequently (co)polymerized. The objectives for this are clear: not only can a reduction in workload, waste and energy consumption be achieved, but also the synthesis of complex products that are otherwise difficult to obtain (*e.g.*, because of thermodynamic hurdles) comes within reach. In other words, the combination of chemistries may allow the direct synthesis of macromolecules with high structural complexity.

Therefore we want to direct investigative efforts toward the synthesis of new **renewable monomers** and the subsequent catalytic conversion of these monomers into their corresponding polymers.[3] The general and challenging idea of the present project is to use a tandem procedure of combining synthesis of new biomass derived monomers with subsequent polymerization by well-defined molecular or silica-supported metal-based catalysts, aiming at novel polymeric materials.



Scheme 1. Tandem synthesis of aliphatic polyureas and polyurethanes

Required background of the student: Organic Chemistry, Polymer Chemistry, Catalysis

A list of 5 (max.) representative publications of the group:

1. C. Robert, F. de Montigny, C. M. Thomas, *Nature Communications*, **2011**, DOI: 10.1038/ncomms1596.
2. C. M. Thomas, J.-F. Lutz, *Angewandte Chemie International Edition*, **2011**, *50*, 9244-9246.
3. J. Guo, P. Haquette, J. Martin, K. Salim, C. M. Thomas, *Angewandte Chemie International Edition* **2013**, *52*, 13584-13587.

Research Topic for the ParisTech/CSC PhD Program

Field: Chemistry, Physical Chemistry and Chemical Engineering

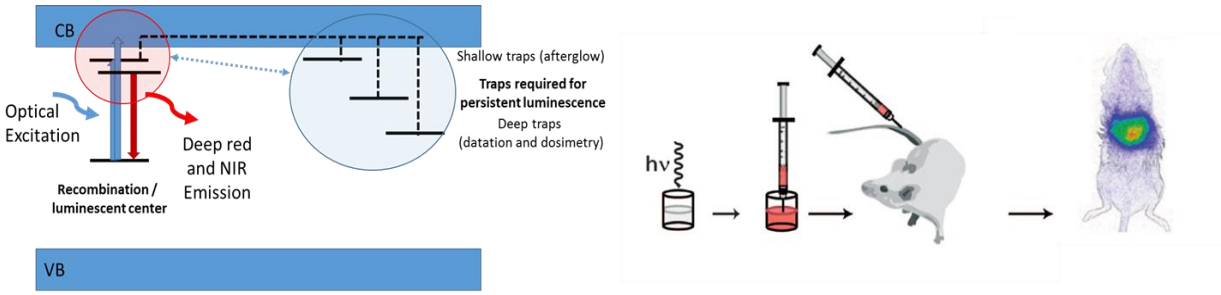
Subfield: Chemistry & Materials Science

Title: Phosphors with long persistent luminescence in the near infrared range for bioimaging

ParisTech School: Chimie Paristech

Advisor(s) Name: Dr Bruno Viana
Advisor(s) Email: bruno.viana@chimie-paristech.fr
(Lab, website): http://ircp.cnrs.fr

Short description of possible research topics for a PhD:
Persistent luminescence is a singular property of some materials which are able to store the excitation or light irradiation energy at intrinsic traps or defects before slowly emitting lower energy photons within several hours (see figure). Several new applications are envisioned with these materials. In that context, bioimaging constantly demands more sensitive tools intended for biomedical research and medical applications. Deep red persistent luminescence nanoparticles have recently been introduced to enable highly sensitive *in vivo* optical detection and complete avoidance of tissue autofluorescence (see figure). We proposed within this research program a novel generation of optical nanoprobes, presenting long persistent luminescence in the near infrared biological window between 1000 nm and 1550 nm. Functionalization of this new photonic probes can be adjusted as well as the wavelength of the optical stimulation to favour multiple challenging applications.



Required background of the student: Materials Science, Chemistry, Optical Spectroscopy

A list of representative publications of the group:
[1] T. Maldiney, et al. "The *in vivo* activation of persistent nanophosphors for optical imaging of vascularization, tumours and grafted cells", *Nature Materials 13*, 418-426 **(2014)**.
[2] D. Jaque, et al. "Inorganic nanoparticles for optical bioimaging" *Advances in Optics and Photonics* 8 (1), 1-103 **(2016)**
[3] S. Sharma; et al. "Persistent luminescence induced by near infra-red photostimulation in chromium-doped zinc gallate for in vivo optical imaging" *Optical Materials* 63, 51-58 **(2017)**
[4] M. Pellerin et al. "LaAlO3: Cr3+, Sm3+: Nano-perovskite with persistent luminescence for in vivo optical imaging" *Journal of Luminescence* 202, 83-88 **(2018)**
[5] J. Xu et al. "Toward Rechargeable Persistent Luminescence for the First and Third Biological Windows via Persistent Energy Transfer and Electron Trap Redistribution" *Inorganic chemistry* 57 (9), 5194-5203 **(2018)**

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Chemistry, Physical Chemistryand Chemical Engineering

Subfield: Corrosion, Surface Chemistry

Title: Corrosion protection at the nanoscale

ParisTech School: Chimie ParisTech

Advisor(s) Name: Philippe Marcus (philippe.marcus@chimie-paristech.fr),Vincent Maurice (vincent.maurice@chimie-paristech.fr), Institur de Recherche de Chimie Paris/Group of Physical Chemistry of Surface

Short description of possible research topics for a PhD:
The IRCP/PCS group at Chimie ParisTechinvestigates how functional metals and alloys corrode in aggressive aqueous and/or high temperature oxygen-containing environments, how to improve their resistance, and how to design innovative protection strategies.
A PhD topic would be to investigate, at the nanometer scale, the role in the corrosion initiation of the chemical and structural heterogeneitiescreated in ultrathin (< 2 nm) passive oxide films by the oxidation/passivation mechanisms. You would study high purity Cr-containing stainless alloy surfaces in a well-defined corrosive aqueous environment, and adopt a novel methodology combining surface preparation of single crystal substrate surfaces, controlled formation of model oxidized interfaces and surface characterisation under UHVenvironment before and after electrochemical modification in the corrosive liquid environment.
Another PhD topic would be to characterise and understand the local corrosion properties at the emergence of grain boundaries at a metal surface. You would study a high purity metal in a model corrosive aqueous environment and adopt a novel methodology combining Electrochemical STM and EBSD. The research work would include the surface preparation of the model microcrystalline samples and the *in situ* characterisation of the global electrochemical properties and local corrosion properties, including the role of corrosion inhibitors.

Required background of the student: Materials Science, Electrochemistry; some knowledge of Corrosion and Surface Science would be beneficial.

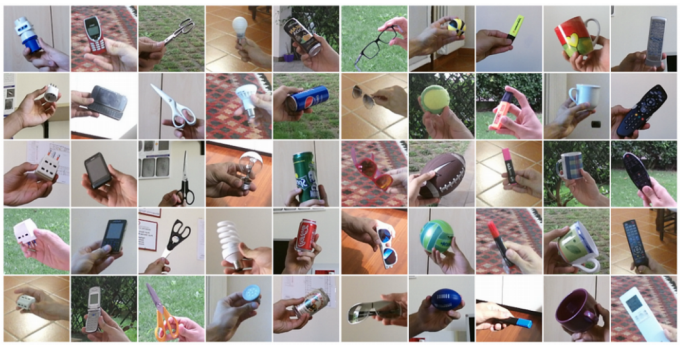
A list of 5(max.) representative publications of the group:

- V. Maurice, P. Marcus, Progress in Corrosion Science at Atomic and Nanometric Scales *Passive films at the nanoscale*, Progress in Materials Science 95 (2018) 132-171.
- V. Maurice, P. Marcus, Current developments of nanoscale insight into corrosion protection by passive oxide films, Current Opinion in Solid State & Materials Science 22 (2018) 156-167.
- Li Ma, F. Wiame, V. Maurice, New insight on early oxidation stages of austenitic stainless steel from in situ XPS analysis on single-crystalline Fe-18Cr-13Ni, Corrosion Science 140 (2018) 205-216.
- M. Bettayeb, V. Maurice, L. H. Klein, L. Lapeire, K. Verbeken, P. Marcus, Nanoscale Intergranular Corrosion and Relation With Grain Boundary Character as Studied In Situ on Copper, Journal of the Electrochemical Society 165 (2018) C835-C841.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Information and Communication Sciences and Technologies
Subfield (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc): Computer Engineering, Robotics, Artificial Intelligence.
Title: Explainable neural-symbolic learning
ParisTech School: ENSTA ParisTech
Advisor(s) Name: Ass. Prof. Natalia Diaz Rodriguez
Advisor(s) Email: natalia.diaz@ensta-paristech.fr
(Lab, website): asr.ensta-paristech.fr https://flowers.inria.fr/

Short description of possible research topics for a PhD:
Current Deep Learning methods are powerful but data-hungry, sample inefficient and hard to interpret. On the other hand, classic knowledge based approaches such as logics, or rule based systems are endowed with less generalization capabilities. However, the latter are fully explainable. The objective of this project is to combine the best of both paradigms by using recent advances on relational deep learning and symbolic reinforcement learning to make black box neural models more explainable. For this purpose, specific datasets will be created in order to test abilities for a neural network to learn spatial and relational ontological properties that are inherent to description logics. Data, tasks and methods will be proposed to ameliorate the problem of standard memory architectures struggling at tasks that heavily involve understanding the way in which entities are connected, estimating cause-effect relations, or conditional independences. The learning of finer grained semantic levels of description logics will be tested for explainability in computer vision real-life applications in order to produce interpretable rules or hypotheses to allow 1) more trusted AI models, and 2) models closer to human common-sense reasoning.



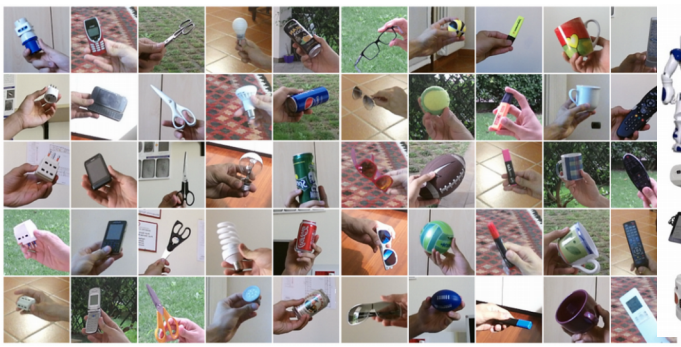
Required background of the student (Which should be the main field of study of the applicant before applying): Computer Science/Engineering, Programming, Deep learning and Reinforcement Learning
A list of 5(max.) representative publications of the group: (Related to the research topic)
[1] T Lesort, N Díaz-Rodríguez, D Goudou, Jean-François, Filliat. S-RL Toolbox: Environments, Datasets and Evaluation Metrics for State Representation Learning. 2018.
[2] Raffin, A Hill, R Traoré, T Lesort, N Díaz-Rodríguez, D Filliat State Representation Learning for Control: An Overview. 2018. arXiv:1809.09369
[3 S Doncieux, D Filliat, N Diaz-Rodriguez, T Hospedales, R Duro, A Coninx, … Open-ended Learning: a Conceptual Framework based on Representational Redescription. 2018. Frontiers in Neurorobotics 12, 59
[4] M Garnelo, K Arulkumaran, M Shanahan. Towards deep symbolic reinforcement learning Deep Reinforcement Learning . NIPS Workshop 2016.
[5] Evans, R. and Grefenstette, E. Learning explanatory rules from noisy data. 2018. Journal of Artificial Intelligence Research , 61:1–64.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Information and Communication Sciences and Technologies
Subfield (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc): Computer Engineering, Robotics, Artificial Intelligence.
Title: Development of Avalanche: a comprehensive framework for continual learning research
ParisTech School: ENSTA ParisTech
Advisor(s) Name: Ass. Prof. Natalia Diaz Rodriguez
Advisor(s) Email: natalia.diaz@ensta-paristech.fr
(Lab, website): asr.ensta-paristech.fr https://flowers.inria.fr/

Short description of possible research topics for a PhD:

Being able to learn continually from non-stationary and ephemeral data streams (especially where data cannot be stored for legal, privacy or hardware constraints) constitute a real challenge for current deep learning techniques. Lifelong or Continual Learning (CL) consists of algorithms that learn about the external world continuously and adaptively through time, enabling the incremental development of ever more complex skills and knowledge. This project consists in developing a software framework to serve the research community to reliably and efficiently prototype and better evaluate CL methods in terms of catastrophic forgetting of the neural network after learning a task, knowledge transfer and scalable generalization capabilities within memory/computational resource constraints, across domains and benchmarks. The framework will include a coherent suite of environments, datasets, baseline algorithms, benchmarks and metrics for developing Continual Learning systems. After implementing the essential state-of-the-art CL strategies, new continual learning algorithms will be designed and tested in robots in the lab for heterogeneous tasks around autonomous systems, including object recognition, autonomous navigation and/or reinforcement learning.



Required background of the student (Which should be the main field of study of the applicant before applying): Computer Science/Engineering, Programming, Deep learning and Reinforcement Learning

A list of 5(max.) representative publications of the group:

[1] T Lesort, N Díaz-Rodríguez, D Goudou, Jean-François, Filliat. S-RL Toolbox: Environments, Datasets and Evaluation Metrics for State Representation Learning. 2018.
[2] Raffin, A Hill, R Traoré, T Lesort, N Díaz-Rodríguez, D Filliat State Representation Learning for Control: An Overview. 2018. arXiv:1809.09369
[3] S Doncieux, D Filliat, N Diaz-Rodriguez, T Hospedales, R Duro, A Coninx, … Open-ended Learning: a Conceptual Framework based on Representational Redescription. 2018. Frontiers in Neurorobotics 12, 59
[4] Caselles-Dupré, H., Annabi, L., Hagen, O., Garcia-Ortiz, M., and Filliat, D. Flatland: a Lightweight First-Person 2-D Environment for Reinforcement Learning. 2018. ArXiv e-prints.
[5] Maltoni, D. and Lomonaco, V. Continuous learning in single-incremental-task scenarios. 2018. arXiv preprint arXiv:1806.08568

Research Topic for the ParisTech/CSC PhD Program

Subfield: Mechanical Engineering, Materials Science and Thermodynamics.

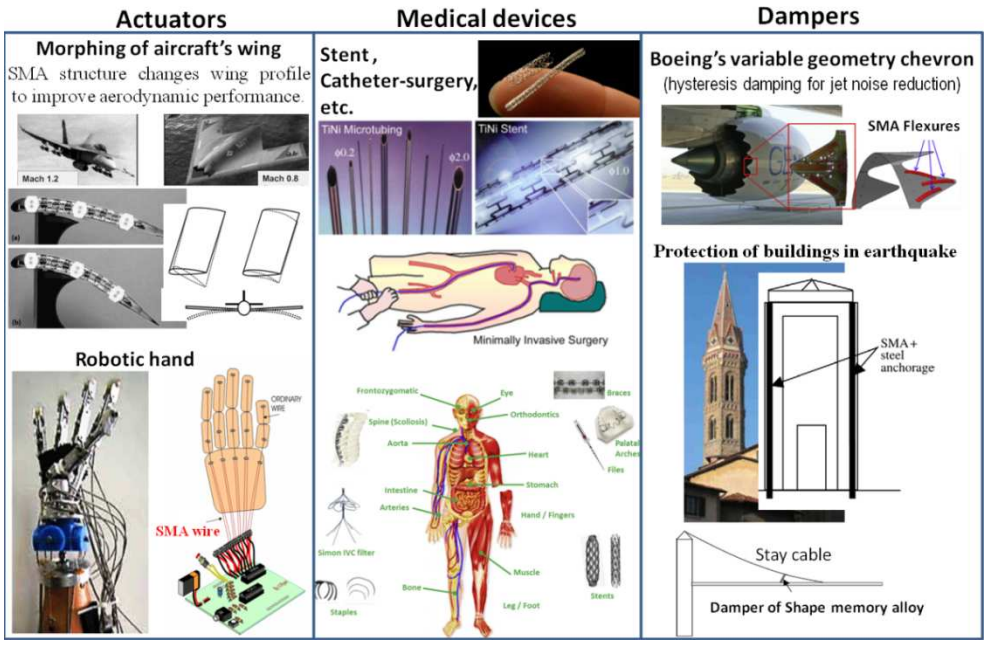
ParisTech School: ENSTA ParisTech

Title: **Development of fatigue-resistant shape memory alloys by microstructure optimization**

Advisor: Yongjun HE (Email: yhe@ensta.fr) *Website*: https://cv.archives-ouvertes.fr/yongjun-he

Short description of possible research topics for a PhD:

Shape memory alloy (SMA) is a multi-functional material which can "remember" its original shape even after complicated thermo-mechanical loadings. Its properties—shape memory and superelasticity enable many applications in automotive, aerospace, robotic and biomedical devices (see figure). The superior properties are due to a solid-solid phase transition (Martensitic phase transformation) which triggers large recoverable deformation and leads to various microstructures—distributions of different phases and orientations, their compatibility and the associated dissipative evolution. The variety of the microstructures makes possible a wide range of applications, for example, SMA earthquake dampers of a large hysteresis (large energy absorption/dissipation) and robotic SMA actuators of a small hysteresis (small dissipation). Recent researches show that the fatigue life of the material under cyclic thermo-mechanical loadings can't meet the requirements (e.g., a medical "stent" requires at least 10^7 cycles). To improve the resistance to fatigue, this research is to modify the material microstructure by theoretical optimization methods (with micromechanics, homogenization methods, phase-field model, etc.) and/or experimental tests/fabrication (with modification of chemical compositions, thermo-mechanical treatments, composite structures, etc.).



A list of 5 (max.) representative publications of the group: (Related to the research topic)

[1] **Y.J. He**, Q.P. Sun. "On non-monotonic rate dependence of stress hysteresis of superelastic shape memory alloy bars". *International Journal of Solids and Structures* 48, 1688-1695 (2011).

[2] H. Yin, **Y.J. He**, Q.P. Sun, "Effect of deformation frequency on temperature and stress oscillations in cyclic phase transition of NiTi shape memory alloy", *Journal of the Mechanics and Physics of Solids* 67, 100–128(2014).

[3] L. Zheng, **Y.J. He**, Z. Moumni "Lüders-like band front motion and fatigue life of pseudoelastic polycrystalline NiTi shape memory alloy" *Scripta Materialia* 123, 46–50 (2016).

[4] H. Yin, **Y.J. He**, Z. Moumni, Q.P. Sun "Effects of grain size on tensile fatigue life of nanostructured NiTi shape memory alloy" *International Journal of Fatigue* 88, 166–177 (2016).

[5] S. Zhang and **Y.J. He** "Fatigue resistance of branching phase-transformation fronts in pseudoelastic NiTi polycrystalline strips" *International Journal of Solids and Structures* 135, 233–244 (2018).

Research Topic for the ParisTech/CSC PhD Program

Subfield: Mechanical Engineering, Materials Science, Applied Physics and Biology.

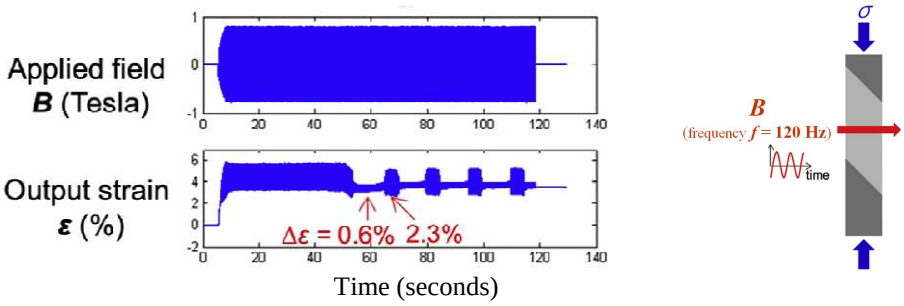
ParisTech School: ENSTA ParisTech

Title: **Complex dynamics of active systems**

Advisor: Yongjun HE (Email: yhe@ensta.fr) *Website*: https://cv.archives-ouvertes.fr/yongjun-he

Short description of possible research topics for a PhD:

Classical active systems, also named as smart/intelligent materials/systems have multi-physics coupling behaviours such as piezoelectricity, magnetostriction and shape memory alloys in the engineering applications of actuators, sensors, energy harvesting, refrigeration, robots, etc. Recently, the concept of activeness was extended in the research of "active matter" whose behaviours are driven by not only the external multi-physics loadings, but also its self-powered constituents. Such active system composed of many self-propelled particles/elements demonstrates many interesting self-organized phenomena/behaviours. The most impressive and complex self-organized system is a biological system with living matters such as cells. While intensive research has been taken for the multi-physics coupling behaviours in classical active systems, there are few convincing theories/principles to describe/understand the essential features of active matters or biological systems because of their complex physics-chemical coupling dynamic processes. For example, the growth and division of a cell depends on the evolution of the cell's membrane which is strongly sensitive to both mechanical force and chemical environment conditions. The current project is to extend the well-established multi-physics coupling models/principles to describe/understand the autonomous evolution of a general active system under various physics-chemical conditions. Particularly, new methods need to be developed to simplify the extremely complex coupling processes in biological systems and extract the essential features of life; for example, the criteria for developing real or artificial (synthetic) autonomous living cycles (the size of a cell cyclically increases and decreases due to cell growth and division). Finally, a general theoretical framework will be proposed to unify the dynamics of physical change and chemical reaction, which are usually treated separately in literature.



"Autonomous" (self-organized) oscillation occurred in a classical active system (The cyclic oscillation of strain amplitude of a Magnetic Shape Memory Alloy under a given magnetic field developed automatically) [4, 5].

A list of 5 (max.) representative publications of the group: (Related to the research topic)

[1] **Y.J. He**, X. Chen, Z. Moumni. "Two-dimensional analysis to improve the output stress in ferromagnetic shape memory alloys". *Journal of Applied Physics* 110, 063905 (2011).

[2] **Y.J. He**, X. Chen, Z. Moumni, "Reversible-strain criteria of ferromagnetic shape memory alloys under cyclic 3D magneto-mechanical loadings". *Journal of Applied Physics* 112, 033902 (2012).

[3] X.Chen, Z. Moumni, **Y.J. He**, W. Zhang,"A three-dimensional model of magneto-mechanical behaviors of martensite reorientation in ferromagnetic shape memory alloys", *Journal of Mechanics and Physics of Solids* 64, 249–286 (2014).

[4] S. Zhang, X. Chen, Z. Moumni, **Y.J. He** "Thermal effects on high-frequency magnetic-field-induced martensite reorientation in ferromagnetic shape memory alloys: An experimental and theoretical investigation" *International Journal of Plasticity* 108. 1–20 (2018).

[5] S. Zhang, X. Chen, Z. Moumni, **Y.J. He** "Coexistence and compatibility of martensite reorientation and phase transformation in high-frequency magnetic-field-induced deformation of Ni-Mn-Ga single crystal" *International Journal of Plasticity* 110, 110–122 (2018).

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Subfield: Physical Chemistry, Renewable Energy

ParisTech School: ENSTA ParisTech

Title: Experimental and modeling study of thermal decomposition of Biomass

Advisor(s): Johnny Deschamps (Prof.), johnny.deschamps@ensta-paristech.fr, Laurent Catoire (Prof.), laurent.catoire@ensta-paristech.fr

Short description of possible research topics for a PhD:

Growing concerns about Green House Gas emissions and depleting of fossil fuel sources have promoted great interest in the use of renewable resources for fuels and chemicals. The decomposition of lignocellulosic biomass which is a complex material made of cellulose, lignin, and hemicelluloses, is a potential source of energy through different upgrading processes. The variety of products that can be obtained (e.g. syngas, biofuel, biogas…) makes this option interesting but for targeting a profitable solution, a better understanding of the chemistry is necessary to optimize and to characterize the use of biomass. The main goal of the Ph.D project proposed here is the experimental and modeling study of thermal decomposition of Biomass. The experimental part will be focused on the pyrolysis of the lignocellulosic biomass, and its principal constituents. The measurements will be performed by using a pyrolyser and a thermogravimetric analyzer (TGA) coupled to gas chromatograph and mass spectrometer (GC-MS), and a gas chromatograph (GC) equipped with a thermal conductivity detector (TCD). The solid residues will be characterized by using different methods of analysis such as surface area measurements (BET), elemental analysis, and microscopy (SEM, TEM). The identification of the decomposition products including permanent gases exhausted will then allow the understanding of the phenomena, and the proposal of a detailed chemical kinetic model of the biomass compounds decomposition, and the development of 2nd generation biofuels. This modeling part will be performed by using specific softwares specifically adapted to this purpose
This PhD project can lead to an academic career in physical chemistry or to positions as engineers in international industries related to energy and renewable energy.

Required background of the student: Energy, solid background in Physical Chemistry.

A list of 5(max.) representative publications of the group: (Related to the research topic)

J. Liang, C. Deng, K. Chatelain, M. Matrat, J. Deschamps, L. Catoire, ‘’ Pyrolysis of selected molecules for second generation biofuels production’’, *Energy and fuel*, to be submitted 2018.

A. Osmont, L. Catoire, P. E. Bocanegra, I. Gökalp, B. Thollas, J. A. Kozinski, ‘’Second generation biofuels: Thermochemistry of glucose and fructose’’, *Combustion and Flame*, 157, 2010, 1230-1234.

L. Catoire, M. Yahyaoui, A. Osmont, I. Gökalp, M. Brothier, H. Lorcet, D. Guénadou, ‘’Thermochemistry of compounds formed during fast pyrolysis of lignocellulosic biomass’’, *Energy & Fuels*, 22, 2008, 4265-4273.

A. Osmont, L. Catoire, I. Gökalp, ‘’Thermochemistry of methyl and ethyl esters from vegetable oils’’, *International Journal of Chemical Kinetics*, 39, 2007, 481-491.

Research Topic for the ParisTech/CSC PhD Program

Field : Physics, Optics

Subfield: femtosecond laser, laser-matter interaction, plasmas

Title: Laser-plasma interaction using single-cycle laser pulses

ParisTech School: ENSTA

Advisor(s) Name: Jérôme FAURE
Advisor(s) Email: jerome.faure@ensta.fr
(Lab, website): http://loa.ensta-paristech.fr/appli/

Short description of possible research topics for a PhD:
In our group, we are trying to generate the shortest electron beams ever produced in the laboratory, i.e. electron pulses of a few femtoseconds only. Such electron pulses could have a huge impact because they can be used to probe matter on the atomic scale and with unprecedented temporal resolution. *They could be used to literally see atoms move in a molecule for example, or in the crystal lattice of a solid.* In order to create short electron pulses, we rely on the interaction of a very intense laser with a gas. When the femtosecond laser is focused into the gas, it creates a plasma, i.e. a fully ionized gas. We use the interaction between the laser and the plasma to accelerate electrons in very short distances, thereby creating miniature particle accelerators. The specificity of our research comes from the fact that we use a unique laser in which the laser pulses are composed of a single optical cycle, i.e. they have a duration of only 3.5 fs! This unique instrument allows us to accelerate electrons to almost the speed of light and the electron pulse has femtosecond duration. The student will study the physics of laser-plasma interaction in this new regime. He (she) will study the influence of many experimental parameters: the carrier envelope phase, the type of gas, the gas jets… The goal will be to understand the interaction physics in the single cycle regime and use that knowledge to optimize the electron source. Once the electron source is fully operational, the student will use the electron to visualize the motion of atoms in material, in ultrafast electron diffraction experiments. The work will essentially be experimental: development of an experimental set-up, data collection, data analysis and interpretation. Theory and simulations will be used to model and interpret the experimental results.

Required background of the student:
Strong background in general physics. Knowledge in one or several of the following will be appreciated: plasma physics, nonlinear physics, optics and lasers. The work will be essentially experimental and we are seeking a candidate who is highly motivated by cutting-edge experiments. A taste for theory will also be appreciated.

A list of 5(max.) representative publications of the group:
- "High-charge relativistic electron bunches from a kHz laser-plasma accelerator"; D. Gustas et al., Phys. Rev. Acc. & Beams **21**, 013401 (2018)
- "Relativistic electron beams driven by kHz single-cycle light pulses"; D. Guénot et al., Nature Photonics 11, 293 (2017)
- "Capturing structural dynamics in crystalline silicone using chirped electrons from a laser wakefield accelerator"; Z. He et al., Sci. Rep. 6, 36224 (2016)
- "Vacuum laser acceleration of relativistic electrons using plasma mirror injectors"; M. Thévenet, et al., Nature Physics 12, 355 (2016)

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Physics, Optics

Subfield: Ultrafast Optics

Title: Generation of single-cycle laser pulses and study of their interaction with a plasma mirror

ParisTech School: ENSTA

Advisor(s) Name: Rodrigo Lopez-Martens, Stefan Haessler
Advisor(s) Email: ***rodrigo.lopez-martens@ensta-paristech.fr***, ***stefan.haessler@ensta-paristech.fr***
(Lab, website): http://loa.ensta-paristech.fr/pco/

Short description of possible research topics for a PhD:
Femtosecond laser pulses allow examining matter under extreme conditions. We are particularly interested in the collective electron dynamics driven in plasmas by the light-field oscillations of pulses whose duration approaches a single optical cycle (≈ 3 fs). These dynamics become spectacular when the laser field reaches intensities beyond 10^{18} W/cm^2: the oscillating electrons are then accelerated to relativistic velocities, ≈c, in a fraction of the optical cycle. This relativistic regime of laser-plasma interaction is of great academic and technological interest and motivates the development of ever more powerful (petawatt) lasers. We focus on the development of smaller lasers with post-compression technology that allow accessing this regime with near-single-cycle pulses at high (kHz) repetition rate. These cutting-edge lasers then drive laser-plasma-interaction experiments on solid surfaces, in particular in the relativistic regime where the plasma becomes a secondary source of (attosecond) high-harmonic emission as well as ultrashort bunches of accelerated electrons and ions. Students can work on the laser technology development, the secondary-source development, as well as fundamental aspects of laser-driven plasma dynamics, both in the experiment and in simulations.

Required background of the student:
The candidate should have a solid background in physics, most importantly in optics. Previous practical experience in an ultra-fast optics laboratory would be greatly appreciated. A strong bias towards patient and precise practical lab-work with the joy of playing with technology would be ideal.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. Böhle, F. *et al.* Compression of CEP-stable multi-mJ laser pulses down to 4 fs in long hollow fibers. *Laser Physics Letters* **11,** 095401 (2014)
2. Borot, A. *et al.* High repetition rate plasma mirror device for attosecond science. *Review of Scientific Instruments* **85,** 013104 (2014)
3. Jacqmin, H. *et al.* Passive coherent combining of CEP-stable few-cycle pulses from a temporally divided hollow fiber compressor. *Opt. Lett.* **40,** 709–712 (2015).
4. Wheeler, J. A. *et al.* Attosecond lighthouses from plasma mirrors. *Nature Photonics* **6,** 829–833 (2012)
5. Kühn, S. *et al.* The ELI-ALPS facility: the next generation of attosecond sources. *J. Phys. B: At. Mol. Opt. Phys.* **50,** 132002 (2017)

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Chemistry, Physical Chemistry and Chemical Engineering

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…). Energy and environment. CO2 capture, NOx capture.

Title: Modelling the thermodynamic properties of electrolyte systems. Application to the simulation of novel flue gas treatment processes

ParisTech School: ENSTA ParisTech

Advisor(s) Name: Patrice PARICAUD, professor of Chemical Engineering
Advisor(s) Email: *patrice.paricaud@ensta-paristech.fr*
(Lab, website): *http://ucp.ensta-paristech.fr/equipe/paricaud.php*

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Flue gas treatment is the process used to reduce the amount of pollutants emitted from the combustion of fossil fuels (coal, natural gases, wood, …). It is crucial for the reduction of pollution from coal / diesel power plants. Flue gases contain a significant amount of nitrogen oxides, CO2, and sulfuric compounds (H2S, SO2) that affect the quality of air. These compounds can be captured by using different processes such as scrubbing columns. The chemicals used in these columns to capture pollutants are mainly electrolyte aqueous solutions. The flue gas treatment requires a significant amount of energy (heat) during the desorption process of the pollutants. In order to assess the amount of energy needed and the efficiency of the process, one must perform a reliable design by using a process simulation software based on an accurate thermodynamic model. Such a model should take into account all chemical reactions and ionic species. The aim of this project is to develop a reliable thermodynamic model for electrolyte solutions and apply it for the simulation of novel gas treatment processes.

Required background of the student: (Which should be the main field of study of the applicant before applying)

The student should have a master degree in chemistry, physics, energy, or chemical engineering. He/she must have a good background in chemistry, maths and programming.

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] A. G. Perez, C. Coquelet, P. Paricaud, A. Chapoy, Fluid Phase Equilib, 440, 19-35 (2017).
[2] P. Babu, P. Paricaud, P. Linga, Fluid Phase Equilib., 413, 80-85 (2016).
[3] A. Fukumoto, P. Paricaud, D. Dalmazzone, W. Bouchafaa, T.T.S. Ho, W. Fürst, J. Chem. Eng. Data, 59, 3193-3204 (2014)

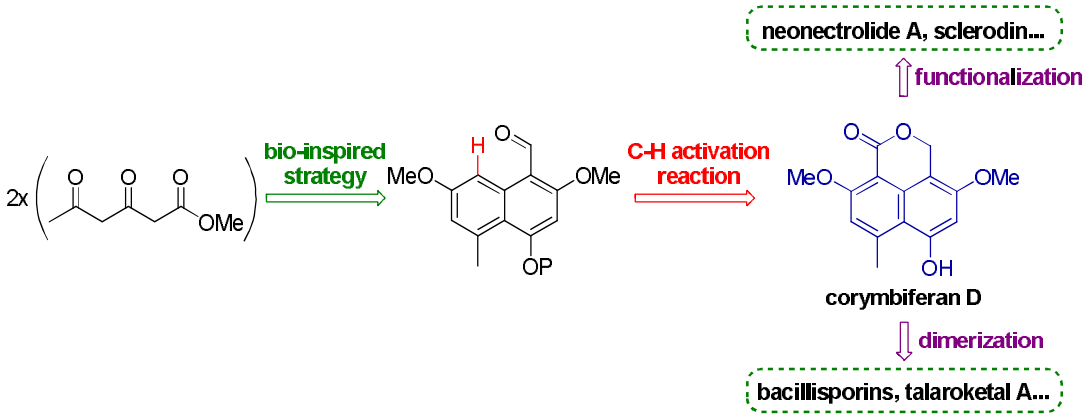
Research Topic for the ParisTech/CSC PhD Program

Field: Chemistry
Subfield: Organic chemistry

Title: Aromatic fungal polyketide synthesis: when bio-inspiration meets C–H activation

ParisTech School: ENSTA ParisTech
Advisor(s) Name: Sébastien Prévost
Advisor(s) Email: sebastien.prevost@ensta-paristech.fr
(Lab, website): https://portail.polytechnique.edu/lso/en/research-groups/asymmetric-catalysis-and-natural-product-synthesis

Short description of possible research topics for a PhD:
Polyketides are an important class of highly biologically active secondary metabolites. A lot of antibiotics or antitumor agents are derived from polyketides. Due to the antibiotic resistance problem, the synthesis of new biologically active compounds is crucial.
Corymbiferans are aromatic fungal polyketides bearing a characteristic naphthol ring annulated with a 6-membered lactone. This skeleton is commonly found in fungal polyketides, as monomeric or dimeric natural products exhibiting remarkable biological properties. The objective of this PhD will be to combine bio-inspired synthesis of naphthols with C–H activation reactions to develop an approach to corymbiferan D. In addition, new catalytic reactions related to naphthalenes C–H activation will be studied. After that, the corymbiferan intermediate will be used to obtain some very complex natural products (neonectrolide A or talaroketal A). This work will be done in collaboration with biologists to evaluate the activities of the synthesized products.



Required background of the student: The student should have a strong background in organic chemistry, catalysis and total synthesis. Additionally, knowledge in analytical chemistry is required.

A list of 5(max.) representative publications of the group:

(1) Prévost, S.; Dezaire, A.; Escargueil, A. *J. Org. Chem.* **2018**, *83*, 4871-4881.
(2) Dolè Kerim, M.; Jia, S.; Theodorakidou, C.; Prévost, S.; El Kaïm L. *Chem. Commun.* **2018**, *54*, 10917-10920.
(3) Tsuji, N.; Kennemur, J. L.; Buyck, T.; Lee, S.; Prévost, S.; Kaib, P. S. J.; Bykov, D.; Farès, C.; List, B. *Science* **2018**, *359*, 1501-1505.
(4) Prévost, S.; Dupré, N.; Leutzsch, M.; Wang, Q.; Wakchaure, V.; List, B. *Angew. Chem. Int. Ed.* **2014**, *53*, 8770-8773.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Mathematics / mechanics

Subfield: Computational mechanics

Title: Wave propagation in highly heterogeneous media

ParisTech School: ENSTA

Advisor(s) Name: J-F Semblat / S. Chaillat
Advisor(s) Email: jean-francois.semblat@ensta-paristech.fr
(Lab, website): IMSIA / POEMS

Short description of possible research topics for a PhD:
Wave propagation in highly heterogeneous 3D elastic media is a topic of strong interest in seismology, for non-destructive testing, etc. The goal is to investigate elastic wave propagation in highly heterogeneous structures along several tens to hundreds of wavelengths. The numerical complexity (mesh size and refinement) is a crucial issue as well as the radiation conditions at infinity.
The recent advances in fast BEM modelling allows for an efficient and accurate estimation of wave propagation in large 3D media (with respect to the wavelength). Since high velocity contrasts lead to important mesh refinement at interfaces, the numerical complexity is consequently much higher that it may be for smooth heterogeneities. The goal of this PhD is to propose a weak formulation for the BEM/BEM coupling of highly heterogeneous media in the framework of the Fast Multipole Accelerated BEM developed at ENSTA ParisTech in the last recent years. Efficient preconditioning methods will also be investigated.
The accuracy and the complexity of the proposed methods will be assessed in the field of seismology for various theoretical and actual configurations. A verification as well as a validation strategy from actual observations will be performed.

Required background of the student: numerical methods (FEM, BEM), wave propagation

A list of 5(max.) representative publications of the group: (Related to the research topic)

Chaillat S., M. Darbas, and F. Le Louër (2017). Fast iterative boundary element methods for high-frequency scattering problems in 3D elastodynamics. Journal of Computational Physics, 341:429–446.

Meza-Fajardo KC, Semblat JF, Chaillat S., Lenti L. (2016). Seismic-Wave Amplification in 3D Alluvial Basins: 3D/1D Amplification Ratios from Fast Multipole BEM Simulations Bulletin of the Seismological Society of America, 106(3): 1267-1281.

Chaillat S., M. Bonnet (2014). A new Fast Multipole Formulation for the elastodynamic half-space Green's tensor. Journal of Computational physics, 258:787–808.

Chaillat S., J.F . Semblat, and M. Bonnet (2012). A preconditioned 3-D multi-region fast multipole solver for seismic wave propagation in complex geometries. Communications in Computational Physics, 11: 594-609.

Semblat J.F., Pecker A. (2009). Waves and Vibrations in Soils: Earthquakes, Traffic, Shocks, Construction Works, IUSS Press, 500 pages.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): 6. Information and Communication Sciences and Technologies

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…) Robotics

Title: Socio-Affective Touch in Robotics

ParisTech School: ENSTA ParisTech

Advisor(s) Name: Prof. Adriana TAPUS
Advisor(s) Email: adriana.tapus@ensta-paristech.fr
(Lab, website): Computer Science and System Engineering Department; Autonomous Systems and Robotics Lab
http://perso.ensta-paristech.fr/~tapus/eng/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
It is well known from the social sciences and medical literature that stimulation of the skin senses can exert beneficial physiological and psychological effects. Several zones that respond optimally to gentle, slow moving touch are likely to play a direct and significant role in social interactions. The goal of this thesis is the understanding of which human body zones, respond better to different force/velocity stroking/rubbing touch. This work is conducted in a human-robot interaction context. During the thesis a robotic touch system (glove, skin) will be developed. The robotic system will exhibit a socio-affective touch behavior and will adapt its behavior to the context and human user emotional state (based on the valence/arousal spectrum) and profile (personality, preferences, etc.). A model defining social touch will be developed and several machine learning techniques will be used. This PhD subject is at the frontier of social sciences, neurosciences, mechatronics, and robotics.

Required background of the student: (Which should be the main field of study of the applicant before applying): Information and Communication Sciences and Technologies/ Robotics.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. Orefice, P.H., Hafez., M., Ammi, M., and **Tapus, A**. (2018) “Pressure Variation Study in Human-Human and Human-Robot Handshakes: Impact of the Mood”, In Proceedings of the 27th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN) 2018, Tai'an, China, August 2018.
2. Agrigoroaie, R., Cruz-Maya, A., and **Tapus, A.** (2018) "Oh! I am so sorry!": Understanding User Physiological Variation while Spoiling a Game Task", In Proceedings of the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2018), Madrid, Spain, October 2018
3. Orefice, P.H., Hafez., M., Ammi, M., and **Tapus, A**. (2016) " Let's Handshake and I'll Know who You Are: Gender and Personality Discrimination in Human-Human and Human-Robot Handshaking Interaction", In Proceedings of the Humanoids International Conference, Cancun, Mexico, November 2016

Research Topic for CSC PhD Program

Field (cf. List of fields below): Information and Communication Sciences and Technologies

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…) Robotics

Title: Machine Learning for Natural Social Robot Behaviors

ParisTech School: ENSTA ParisTech, France

Advisor(s) Name: Prof. Adriana TAPUS
Advisor(s) Email: adriana.tapus@ensta-paristech.fr
(Lab, website): Computer Science and System Engineering Department; Autonomous Systems and Robotics Lab
http://perso.ensta-paristech.fr/~tapus/eng/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
Social robots are more and more present in our daily life. Robots need to understand the context and human user's behaviors in order to be able to exhibit a natural behavior and to adapt their behavior to the human users they are interacting with. Several modalities are used to express robot's behavior such as verbal, non-verbal (i.e., gestures, postures) and para-verbal (i.e., tone of voice, speed, pitch, etc.). The goal of this thesis is to understand and learn how a robot can use deep learning to observe video recordings of people interacting with each other, and extract and understand which behaviors are appropriate under which circumstances. The learned model will also be implemented on a real robot (Tiago robot, Pepper robot, or Meka robot) and tested in real-time in real social interactions.

Required background of the student: (Which should be the main field of study of the applicant before applying): Information and Communication Sciences and Technologies/ Robotics.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. Cruz, A and **Tapus, A.** (2017) " Learning Users' and Personality-Gender Preferences in Close Human-Robot Interaction", In Proceedings of RO-MAN 2017, Lisbon, Portugal, August 2017
2. Ferland, F., and **Tapus, A.** (2017) "Crowd Sourcing Approach Behavior Control", In Proceedings of RO-MAN 2017, Lisbon, Portugal, August 2017
3. Agrigoroaie, R., Cruz-Maya, A., and **Tapus, A.** (2018) "Oh! I am so sorry!": Understanding User Physiological Variation while Spoiling a Game Task", In Proceedings of the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2018), Madrid, Spain, October 2018

Research Topic for the ParisTech/CSC PhD Program

***Field:** Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Organic Chemistry

Title: Isocyanide Based Multicomponent Reactions and Transition Metal Catalysis

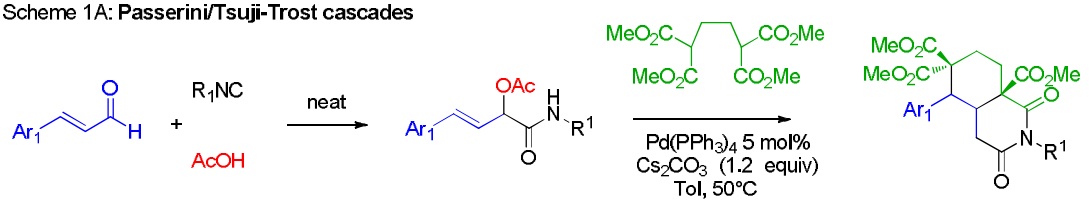
ParisTech School: ENSTA ParisTech
Advisor(s) Name: Laurent El Kaim (*laurent.elkaim@ensta-paristech.fr)*
(Lab, website): *http://ucp.ensta-paristech.fr/sor.php*

Short description of possible research topics for a PhD: The purpose of the project is to bring new tools for the preparation of complex organic derivatives with potential interest for the pharma industry. Isocyanides are carbene type derivatives easily prepared from amines. They are best known for their use in Ugi coupling, a 4-component reaction which has been extensively used for the preparation of libraries of bioactive heterocycles. The ENSTA research group in organic chemistry has a strong expertise in the field of isocyanide based multicomponent reactions (MCRs). We have disclosed in 2005 an important extension of the Ugi reaction known as Ugi-Smiles couplings and have studied various reactions of isocyanides with electrophilic derivatives.[1] Our activities are now following two directions:

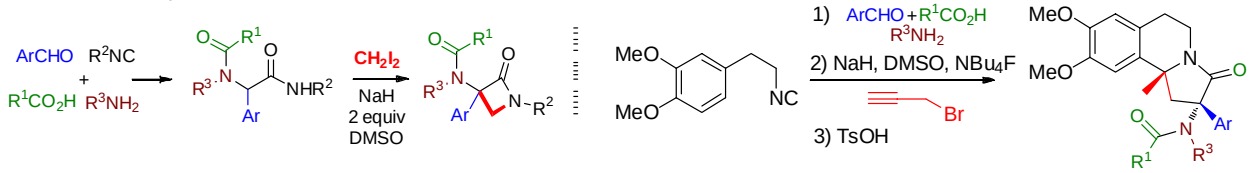
- Use of MCRS to afford fast access to starting material with suitable functionalities for original organometallic transformations (Scheme 1A).[2a,b]
- Chemistry of amide dianions applied to the synthesis of heterocycles (Scheme 1B).[3a,b]
- Nitro chemistry coupled with transition metal catalysis.[4]

This PhD project will focus on Tsuji-Trost reactions working with diamide anions and nitro compounds. IMCRs will be used as much as possible to prepare starting materials and reach libraries of biologically active compounds.

Scheme 1A: **Passerini/Tsuji-Trost cascades**



Scheme 1B: **Ugi/β-lactams:** **Ugi/pyrrolidones:**



Required background of the student: General Organic Chemistry

A list of representative publications of the group:

1)a) L. El Kaïm, L. Grimaud, J. Oble, *Angew. Chem., Int. Ed*, **2005**, *44*, 7961-7964. b)L. El Kaïm, L. Grimaud, *Eur. J. Org. Chem.* **2014** , 7749–7762.

2) a) M. Cordier, A. Dos Santos, L. El Kaïm, N. Narboni, *Chem. Commun.*, **2015**, 51, 6411-6414. b) E. H. El Mamouni, M. Cattoen, M. Cordier, J. Cossy, S. Arseniyadis, H. Ilitki, L. El Kaïm, *Chem. Commun.*, **2016**, *52*, 14490 – 14493.

3a) A. Zidan, L. El Kaim et al, *Angew. Chem Int. Ed*, **2017**, 56, 12179-12183.3b) A. Zidan, L. El Kaim et al, *Org. Lett.*, **2018**, 20, 2568-2571.

4) M. Dolè Kerim, S. Jia, C. Theodorakidou, S. Prévost, L. El kaim, *Chem Commun.* **2018**, in press, 10.1039/C8CC06536E

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below): Environment Science and Technology, Geosciences***

Subfield: Space Weather

Title: Forecasting Solar Eruptions against Space Weather Impacts on Earth infrastructures

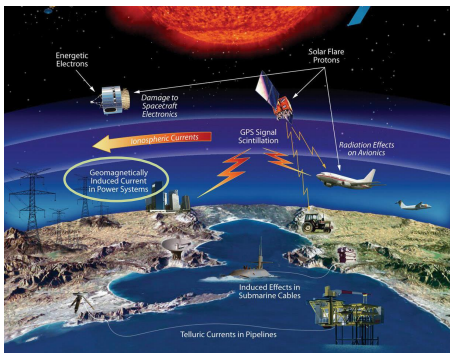
ParisTech School: Ecole Polytechnique

Advisor(s) Name:): Tahar Amari

Advisor(s) Email: : tahar.amari@polytechnique.edu, URL : http://www.cpht.polytechnique.fr/cpht/amari

(Lab, website): Centre de Physique Théorique. Ecole Polytechnique.
http://www.cpht.polytechnique.fr/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
Solar Eruptions may have a strong economic impact on various sectors , power grids, satellites, communications, GPS, living organisms, …. Forecasting eruptions as well as their impact has become a new sector called Space Weather.
This project consists in building an operational model for forecasting the solar environment which includes the regions of the Sun from which eruptions can take off as well the whole Sun global background.



The applicant will work on and with several state-of-the art numerical models developed in the Centre de Physique Théorique, using the solar surface magnetic field obtained from instruments on board present and future satellites. Those models will allow forecast the pre-eruptive signs of eruptions as well key parameters of space weather conditions. The prediction using the models at large distance will be compared to other kind of data, including in situ data close Earth environment.

Required background of the student: (Which should be the main field of study of the applicant before applying)
The applicant should have be trained in modeling, and/or data processing and will thus have followed courses in fields such as : computer science applied to fluid dynamics, physics, astrophysical or laboratory physics.

A list of 5(max.) representative publications of the group: (Related to the research topic)

Amari, T. , Canou A., . Aly J.J , Delyon, F. , Alauzet F. : « Magnetic cage and rope as the key for solar eruptions. » **Nature** 554: 211-215 (2018).

Amari, T. , Luciani J.F., Aly J.J : « Small-scale dynamo magnetism as the driver for heating the solar atmosphere. » **Nature** 522: 188-191 (2015).

Amari, T. , Canou A., . Aly J.J : « Characterizing and predicting the magnetic environment leading to solar eruptions. » **Nature** 514: 465–469 (2014)

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Materials Science, Mechanics, Fluids

Subfield:
Environment Science and Technology, Sustainable Development, Geosciences

Title: Dynamics of turbulence and vortices in stratified-rotating fluids under the complete Coriolis force.

ParisTech School: Ecole Polytechnique

Advisor(s) Name: Paul Billant
Advisor(s) Email: *billant@ladhyx.polytechnique.fr*
(Lab, website): Hydrodynamics *Laboratory of Ecole Polytechnique (LadHyX).*
https://www.ladhyx.polytechnique.fr/en/

Short description of possible research topics for a PhD:
In geophysical fluid dynamics, the effect of the Earth's rotation is generally taken into account as if the Earth were flat. This approximation, called "traditional", consists in considering only the Coriolis force due to the component of Earth's rotation about the vertical axis at a given latitude while the rotation's component along the horizontal is neglected. Yet, the corresponding Coriolis force, called 'non-traditional', can affect several phenomena at intermediate scales in the atmosphere and oceans, especially near the equator since it introduces a misalignment between the buoyancy force and the rotation's vector. This has been evidenced in the particular case of waves and convective motions. In contrast, the effect of the non-traditional Coriolis force on vortices and turbulence is largely unknown.
Hence, the goal of the thesis will be to study its effect on the dynamics of turbulence and vortices by means of direct numerical simulations, theoretical analyses and experiments.

Required background of the student:
Fluid mechanics
Numerical simulations

A list of 5(max.) representative publications of the group: (Related to the research topic)
J. Park and **P. Billant**, 2013 Instabilities and waves on a columnar vortex in a strongly-stratified fluid. Phys. Fluids, 25, 086601.
P. Augier, **P. Billant**, M. E. Negretti and J.-M. Chomaz 2014 Experimental study of stratified turbulence forced with columnar dipôles. Phys. Fluids, 26, 046603.
P. Augier**, P. Billant** and J.-M. Chomaz, 2015 Stratified turbulence forced with columnar dipoles. Numerical study. J. Fluid Mech., 769, 403-443.
E. Yim and **P. Billant**, 2016 Analogies and differences between the stability of an isolated pancake vortex and a columnar vortex in stratified fluid. J. Fluid Mech, 796, 732-766.
J. Park, **P. Billant**, J.-J. Baik, J. Seo, 2018 Competition between the centrifugal and strato-rotational instabilities in the stratified Taylor-Couette flow. J. Fluid Mech, 840, 5-24.

Research Topic for the ParisTech/CSC PhD Program

Field : Materials Science, Mechanics, Fluids
Subfield: Fluid mechanics, fluid/structure interaction, continuum mechanics
Title: Origami: Designing the elastic response of an object in a fluid
ParisTech School: Ecole Polytechnique
Advisor(s) Name: Sophie Ramananarivo & Emmanuel de Langre
Email: sophie.ramananarivo@ladhyx.polytechnique.fr & delangre@ladhyx.polytechnique.fr
(Lab, website): LadHyX, https://www.ladhyx.polytechnique.fr/en/

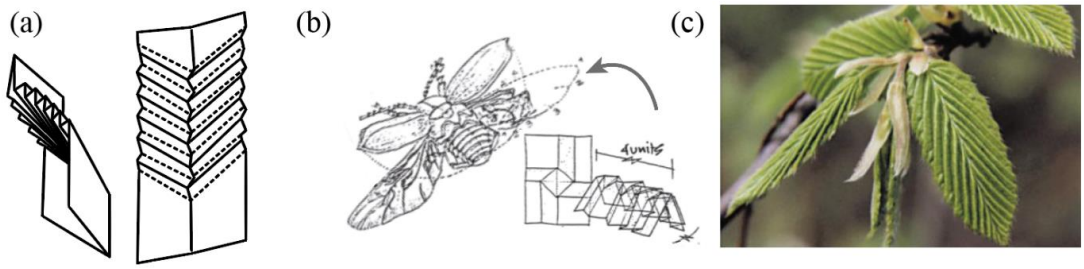


Figure 1: (a) Example of origami that undergo large shape changes while folding along a single degree of freedom. (b-c) Deployment mechanisms and folding patterns of the wing of a beetle and of a hornbeam leaf.

Short description of possible research topics for a PhD:
There is a long-standing interest in the use of compliant materials for robotic propulsion, or energy harvesting from flows [1]. Exploiting passive deformation is a simple way to increases performance without having to resort to complex mechanisms [2,3]. However, the structure has to deform in an appropriate way, that is specific to its function. It is thus important to understand the mechanisms governing the elastic response of an object under fluid loading, and to find ways to control it. Here, we will explore an unconventional route to tailor those deformations, making use of the unique properties of origamis. The geometry of the folds conditions the way the structure deforms, allowing only for certain motion while being rigid to other modes of deformation (Fig.1a). When placed in a flow, such a system will then display different behavior as a function of its orientation, folding into a compact object or conversely expanding. This is for example of interest for the flow-controlled deployment of underwater structures, or the design of valves. Such foldable structures are also commonly used in nature, for example in the opening of buds or the deployment of insect wings (Fig.1b-c). The resulting mechanical properties are likely to improve the wind resistance of plants, or to optimize flight performances of an insect by allowing for the wings to modify their shape in the ascending and descending phase of the flapping motion. We will study those biomechanical mechanisms on model geometries of origami in controlled flows, with potential applications in biomimetic engineering.

Required background of the student:
This PhD will combine experiments and theory. The candidate will have a pronounced taste for experimental work, and will build and study set-ups to understand the mechanical behavior of origamis in a flow. To develop a deeper understanding, this experimental work will be coupled to theoretical and numerical models, relying on tools developed at LadHyX for deformable structures under fluid loading [4]. Strong skills in fluid mechanics, continuum mechanics and/or fluid/structure interaction would be an asset.

A list of 5(max.) representative publications of the group:
[1] Antoine G. O., and de Langre E., and Michelin S. (2016). Optimal energy harvesting from vortex-induced vibrations of cables. Proc. R. Soc. A, 472(2195), 20160583.
[2] Ramananarivo S., Godoy-Diana R., & Thiria B. (2013). Passive elastic mechanism to mimic fish-muscle action in anguilliform swimming. Journal of The Royal Society Interface, 10(88), 20130667.
[3] Ramananarivo S., Godoy-Diana R., & Thiria B. (2011). Rather than resonance, flapping wing flyers may play on aerodynamics to improve performance. Proceedings of the National Academy of Sciences, 108(15), 5964-5969.
[4] Leclercq T. & de Langre E. (2016). Drag reduction by elastic reconfiguration of non-uniform beams in non-uniform flows. Journal of Fluids and Structures, 60 :114-129.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Chemistry, Coordination Chemistry, Catalysis

ParisTech School: Ecole polytechnique

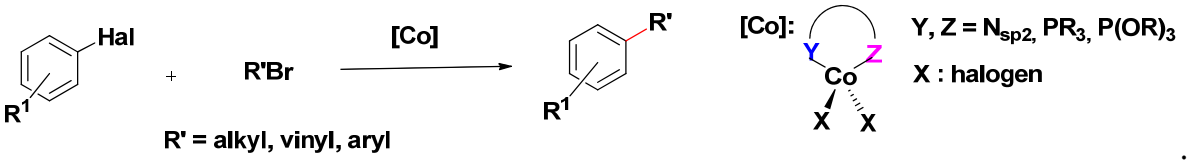
Title: Well defined complexes for cobalt catalysis

Advisor(s): Audrey Auffrant, Corinne Gosmini

audrey.auffrant@polytechnique.edu; corinne.gosmini@polytechnique.edu

Short description of possible research topics for a PhD:

The transition metal catalyzed coupling reactions have revolutionized the synthesis of organic molecules. For these reactions, palladium remains the most used metal nevertheless non-noble and more eco-compatible alternatives based on Cu, Fe, or Co have emerged. We reported some years ago, the first cobalt-catalyzed reductive couplings allowing the formation of C-C bond by reacting two electrophiles. This therefore avoids the preparation of often stoichiometric organometallic partner. In recent years, we have continued our research in this area and tried to take benefit of complementary skills in the laboratory to use well-defined pre-catalysts to perform those reactions with the objective to simplify the reaction mixture (avoiding for example the use of co-solvent), reduce reaction time… Thus, the PhD project deals with the synthesis of cobalt complexes featuring mixed bidentate ligands for the catalysis of reductive couplings.



Required background of the student: organic chemistry and/or catalysis, experience in handling organometallic compounds would be a plus.

Representative publications of the group:

C. Gosmini, J.-M. Bégouin, A. Moncomble *Chem. Commun*. **2008**, 3221; M. Amatore, C. Gosmini, *Chem. Eur. J.* **2010**, *16*, 5848-5852.

X. Qian, Z. Yu, A. Auffrant, C. Gosmini, *Chem. Eur. J.*, **2013**, 19, 20, 6225-6229 ; Y. Cai, X. Qian, A. Rérat, A. Auffrant, C. Gosimini *Adv. Synth. Catal.*, **2015**, *357*, 3419-3423.

Pal, S.; Chowdhury, S.; Rozwadowski, E.; Auffrant, A.; Gosmini, C., *Adv. Synth. Catal.* **2016,** *358*, 2131-2435; Y. Cai, A. D. Benischke, P. Knochel, C. Gosmini *Chem. Eur. J.*, **2017**,23, 250-253.

Research Topic for the ParisTech/CSC PhD Program

Field : Chemistry, Physical Chemistry and Chemical Engineering

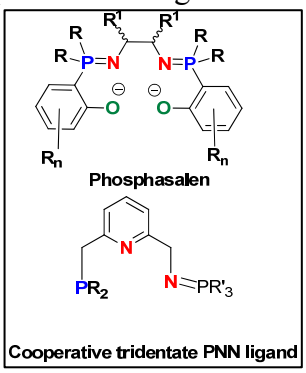
Subfield: Coordination Chemistry and catalysis

Title: **Multidentate iminophosphorane based ligands: coordination chemistry and catalytic applications**

ParisTech School: Ecole polytechnique

Advisor(s) Name: Audrey Auffrant
Advisor(s) Email:Audrey.auffrant@polytechnique.edu
(Lab, website): http://www.polytechnique.edu/annuaire/en/user/10676/audrey.auffrant

Short description of possible research topics for a PhD: Mixed ligands are becoming increasingly important in coordination chemistry and in homogenous catalysis. Polydentate systems containing different complementary heteroatoms have been much investigated because the presence of different coordination sites exhibiting different electronic properties, allow for a fine tuning of the activity of the metal center during the catalytic process.
As we are specialized in the laboratory in iminophosphorane ligands (containing P=N linkage), that display remarkable σ and π donating properties and poor accepting ability, we are interested in developing new polydentate iminophosphorane based ligands. In particular, during the past few years we have shown that phosphasalen, the phosphorous analogue of the well-known salen, can form efficient catalysts for the production of bio-polymers, are able to stabilize metal centers in unusual oxidation state. The objective of the PhD project would be to develop new iminophosphorane based tetra- or tridentate ligands, study their coordination in particular to abundant and cheap first raw metals (Fe, Mn, Co) and demonstrate their catalytic ability. Special attention will be also devoted to cooperative ligands which are able to assist the metal during the catalysis.



Required background of the student: Studies in molecular chemistry an experience in organometallic chemistry or catalysis would be an advantage.

A list of 5(max.) representative publications of the group:

- T. Cheisson, L. Mazaud, A. Auffrant**,** *Dalton Trans.*, **2018**, DOI : 10.1039/C8DT03488E.
- Mustieles-Marín, T. Cheisson, R. Singh Chauhan, C. Herrero, M. Cordier, C. Clavaguéra, G. Nocton, A. Auffrant**,** *Chem. Eur. J.*, **2017**, *23*, 17940-17953.
- T. Cheisson, A. Auffrant, *Dalton Trans.* **2016**, *45*, 2069-2078.
- T. P. A. Cao, G. Nocton, L. Ricard, X. F. Le Goff, A. Auffrant, *Angew. Chem. Int. Ed.* **2014**, *53*, 1368-1372.
- C. Bakewell, T. P. A. Cao, N. Long, X. F. Le Goff, A. Auffrant, C. K. Williams, *J. Am. Chem. Soc.* **2012**, *134*, 20577-20580.

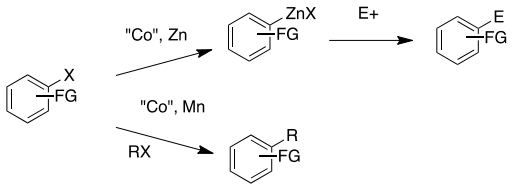
Research Topic for the ParisTech/CSC PhD Program

Field : Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry, Catalysis

Title: Cobalt-catalyzed cross-coupling reactions
ParisTech School: Ecole polytechnique
Advisor(s) Name: Corinne Gosmini
Advisor(s) Email: corinne.gosmini@polytechnique.edu
(Lab, website): *https://portail.polytechnique.edu/lcm/fr*

Short description of possible research topics for a PhD: (Over the past 40 years, the development of transition metal-catalyzed cross-coupling reactions has revolutionized techniques for the formation of carbon-carbon bonds. The cross-coupling reaction class is among the most important in organic synthesis. The development of efficient new carbon-carbon bond forming reactions by metal-catalyzed cross-coupling is still progressing impressively and significant advances have been achieved. Among the different catalysts, the most commonly employed and reliable metals are palladium and nickel. However both these catalysts systems have disadvantages (cost or toxicity). Fortunately, inexpensive alternative catalysts are available such as iron and cobalt. In our laboratory, we have developed cobalt-catalyzed cross-coupling reactions involving organozinc species with various electrophiles and cobalt-catalyzed reductive cross-coupling in order to form C-C bonds.



The proposed PhD project aims to form C-C bonds either by cobalt-catalyzed cross-coupling of different functionalized organozinc species with different electrophiles or by reductive cross-coupling.

The PhD student will therefore have to study different cross-coupling reactions. GC analysis would be used to follow the catalytic trials, and products obtained will be characterized by multinuclear NMR spectroscopy.

Required background of the student: organic chemistry and/or catalysis
A list of representative publications of the group:

-Y Cai, X. Qian, A.Rérat, A. Auffrant , C. Gosmini* *Adv. Synth. Catal.,* **2015,** *357,* 3419-3423 (VIP)

-X. Qian, Z. Yu, A. Auffrant and C. Gosmini* *Chem Eur. J.,* **2013,** *19,* 6225-6229 (Highlighted in Synfacts)

-C. Gosmini*, J.- M. Begouin, A. Moncomble, *Chem. Commun.,* **2008,** 3221-3233.

-H. Fillon, C. Gosmini*, J. Périchon *J. Am. Chem. Soc.,* **2003**, *125*, 3867-3870

Research Topic for the ParisTech/CSC PhD Program

Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Chemistry

Title: Synthesis and magnetic studies of organolanthanide complexes with slow magnetic relaxation

ParisTech School: Ecole polytechnique

Advisor(s) Name: Dr. Grégory Nocton, www.gregory.nocton.fr
Advisor(s) Email: greg.nocton@polytechnique.edu

Short description of possible research topics for a PhD:

The use of molecules as **Single Molecules Magnets** is extremely relevant for the design of quantum computers. On the last 20 years this field has moved very rapidly and the temperature at which the molecules start to behave as a magnet increased to reach 60 K, which is very close to the 77 K of the liquid nitrogen. Closing the gap would be really beneficial for applications. The rare earth metal complexes have largely contributed to the fast increase on the field with their natural large magnetic anisotropy and high magnetic susceptibility. Recently, **organolanthanide complexes** have proven to be extremely useful in this area as well since the metal – carbon bonds enhance the magnetic slow relaxation *via* multiple vibronic coupling. The group has long experience on the difficult synthesis of organolanthanide complexes with trivalent but also divalent metal ions of the rare earths. For example, we have recently developed a very original ligand, specifically designed for divalent organolanthanide chemistry (Figure). Therefore, the research we propose within this project will be devoted to **the synthesis of original organolanthanide complexes with this new ligand in order to study their slow magnetic relaxation** and approach the targeted 77 K.

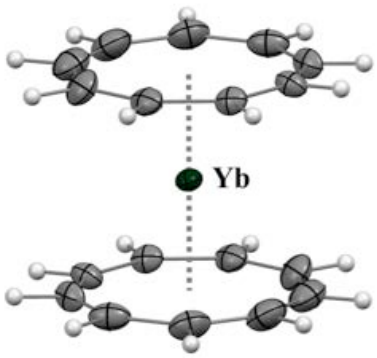


Figure. Structure of the new sandwich complex of $Yb(Cnt)_2$.

Required background of the student: Chemistry student with good knowledge of synthetic chemistry. The knowledge of the specific techniques of inert atmosphere synthesis or magnetism is best but not mandatory.

Representative publications of the group: (Related to the research topic)

- Xémard, M., Zimmer, S., Cordier, M., Goudy, V., Ricard, L., Clavaguéra, C., and **Nocton G.*** *J. Am. Chem. Soc.*, Accepted Manuscript
- Goudy, V., Jaoul A., Cordier M., Clavaguéra, C., **Nocton G.***, *J. Am. Chem. Soc.*, **2017**, 139, 10633-10636
- Xémard, M., Jaoul, A., Cordier, M., Molton, F., Cador, O., Le Guennic, B., Duboc, C., Maury, O.,Clavaguéra, C., **Nocton, G.***, *Angew. Chem. Int. Ed.*, **2017**, *56*, 4266-4271 (back cover)
- Nocton G.*, Ricard L., *Chem. Commun.*, **2015**, *51*, 3578-3581.
- Nocton G.*, Lukens W. W., Booth C. H., Rozenel S. S., Medling S. A., Maron L. and Andersen R. A., *J. Am. Chem. Soc.,* **2014**, *136*, 8626-8641.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field : Chemistry, Physical Chemistry and Chemical Engineering

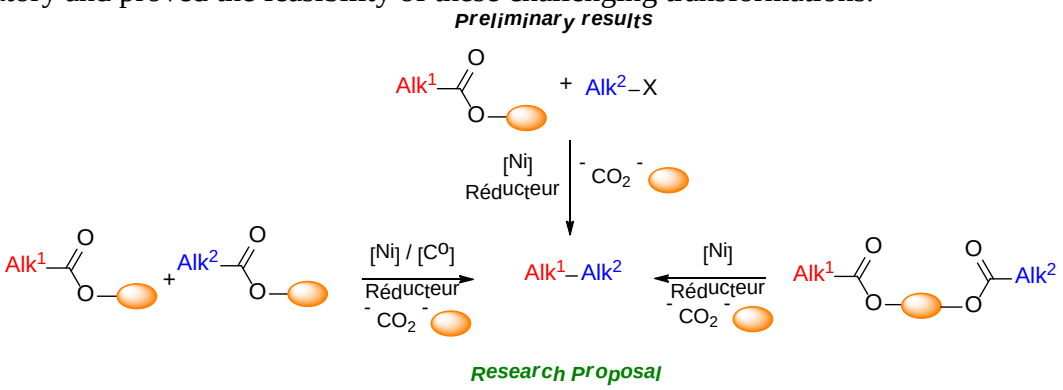
Subfield: Organic Chemistry

Title: Development of Original Decarboxylative Reductive Cross-Couplings

ParisTech School: Ecole Polytechnique

Advisor(s) Name: Grégory Danoun
Advisor(s) Email: gregory.danoun@polytechnique.edu
(Lab, website): https://portail.polytechnique.edu/lcm/fr

Short description of possible research topics for a PhD: Metal catalysis is one the best synthetic tool for C–C bond construction. Much effort was devoted to the development of methods using precious metals such as palladium as catalyst. This impressive synthetic tool was awarded in 2010 by a Nobel Prize. "Classical" coupling reactions are catalysed by a transition metal to couple an electrophile, commonly an aryl halide, and a nucleophile such as an organometallic compound or an aryl boronic acid. The actual environmental concerns require to redesign completely the way to develop these coupling reactions. Therefore, the main goal of the present proposal is to develop original cross-coupling reactions involving cheap and benign carboxylic acid derivatives as sole coupling partners and eco-friendly first-row transition metal as catalyst. In addition to develop eco-compatible cross-coupling reactions, this proposal puts forward the development of new synthetic strategies to form challenging bonds such as C(sp^3)–C(sp^3) bond. Some preliminary results were found in the laboratory and proved the feasibility of these challenging transformations.



Required background of the student: The student should have a strong background in organic chemistry. Experience in catalysis would be an asset (but not mandatory). We are looking for a dedicated and highly motivated candidate. Moreover, the candidate should have good communication skills and a good team spirit.

A list of 5(max.) representative publications of the group:

Y. Bourne-Branchu, C. Gosmini, G. Danoun, *Chem. Eur. J.* **2018**, *accepted*
Y. Bourne-Branchu, C. Gosmini, G. Danoun, *Chem. Eur. J.* **2017**, *23*, 10043
M. Amatore, C. Gosmini, *Angew. Chem. Int. Ed.* **2008**, *47*, 2089-2092.
X. Qian, A. Auffrant, A. Felouat, C. Gosmini, *Angew. Chem. Int. Ed.* **2011**, *50*, 10402-10405.

Research Topic for the ParisTech/CSC PhD Program

***Field*:** Information and Communication Sciences and Technologies

***Subfield*:** Logic

***Title*:** Proofs without Syntax

***ParisTech School*:** Ecole Polytechnique

***Advisor Name*:** Lutz Straßburger

***Advisor Email*:** lutz@lix.polytechnique.fr

***Advisor website*:** http://www.lix.polytechnique.fr/Labo/Lutz.Strassburger/

***Lab*:** Laboratoire d'Informatique de l'École polytechnique (LIX)

***Lab website*:** https://www.lix.polytechnique.fr/

***Short description of possible research topics for a PhD*:**

Proof theory is a central area of theoretical computer science, as it can provide the foundations not only for logic programming and functional programming, but also for the formal verification of software. Yet, despite the crucial role played by formal proofs, we have no proper notion of proof identity telling us when two proofs are "the same". This is very different from other areas of mathematics, like group theory, where two groups are "the same" if they are isomorphic, or topology, where two spaces are "the same" if they are homeomorphic.

The problem is that proofs are usually presented by syntactic means, and depending on the chosen syntactic formalism, "the same" proof can look very different. In fact, one can say that at the current state of art, *proof theory is not a theory of proofs but a theory of proof systems*. This means that the first step must be to find ways to describe proofs independent from the proof systems. In other words, we need a "syntax-free" presentation of proofs.

A recent breakthrough in that direction is the notion *combinatorial proof* which forms a syntax-independent canonical proof representation. The main topic of this PhD will be to participate in the further development of combinatorial proofs, including: (1) extending the theory to richer logics, (2) translating between syntactic proofs and combinatorial proof, and (3) implementing tools using combinatorial proofs.

***Required background of the student*:**

The successful candidate should have a good background in logic, and also some knowledge in one or more areas among the following: proof theory, combinatorics, graph theory, category theory.

***A list of representative publications*:**

1. Lutz Straßburger. Combinatorial Flows and Proof Compression. Research Report RR-9048, Inria Saclay, 2017. URL: https://hal.inria.fr/hal-01498468
2. Lutz Straßburger. Combinatorial Flows and Their Normalisation. In *FSCD 2017 (LIPIcs)*, Dale Miller (Ed.), Vol. 84. Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, 31:1–31:17.
3. Matteo Acclavio and Lutz Straßburger. From syntactic proofs to combinatorial proofs. In Didier Galmiche, Stephan Schulz, and Roberto Sebastiani, editors, *Automated Reasoning - 9th International Joint Conference, IJCAR 2018, Held as Part of the Federated Logic Conference, FloC 2018, Oxford, UK, July 14-17, 2018, Proceedings*, volume 10900, pages 481–497. Springer, 2018.
4. Novak Novakovic and Lutz Straßburger. On the power of substitution in the calculus of structures. *ACM Trans. Comp. Log. 16(3)*, 2015.
5. Lutz Straßburger. From deep inference to proof nets via cut elimination. *Journal of Logic and Computation 21 (4), 589–624*, 2009.

Research Topic for the ParisTech/CSC PhD Program

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry

Title: Palladium-catalyzed transformations of oxyallyl cations

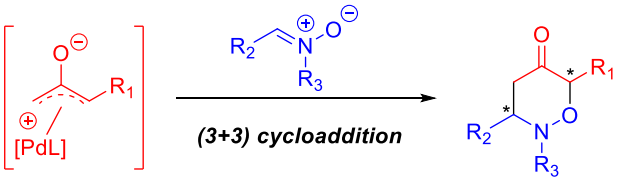
ParisTech School: Ecole Polytechnique

Advisor(s) Name: Alexis Archambeau
Advisor(s) Email: alexis.archambeau@polytechnique.edu
(Lab, website): Laboratoire de Synthèse Organique ; https://portail.polytechnique.edu/lso/en

Short description of possible research topics for a PhD:

In our research group, we focus on the development of original transformations relying on cycloaddition strategies towards the rapid construction of azacycles. In this context, we became interested in the reactivity of oxyallyl cations. In the presence of 1,3-dipoles such as nitrones, we recently showed that a (3+3) cycloaddition can occur to yield functionalized oxazinanones.

This project aims to investigate the reactivity in (3+3) cycloadditions of oxy-π-allylpalladium species. This strategy will allow to control the regio- and diastereoselective outcome of the transformation through a screening of the palladium ligands. Chiral ligands will also be examined to access enantioenriched structures.



The student will 1) find appropriate substrates and conditions to perform this transformation ; 2) develop a diastereoselective version of this transformation relying on modern organometallic catalysis ; 3) survey the potential synthetic applications of these new compounds.

Required background of the student: The applicant must have a strong background in the field of organic chemistry and knowledge of good laboratory practice.

A list of 5(max.) representative publications of the group:

(a) (3+3) Cycloaddition of Oxyallyl Cations with Nitrones: Diastereoselective Access to 1,2-Oxazinanes, Cordier, M.; Archambeau, A. *Org. Lett.*, **2018**, *20*, 2265-2268 *(b) Rhodium(III)-Catalyzed allylic C(sp^3)−H Activation of Alkenyl Sulfonamides: Unexpected Formation of Azabicycles,* Archambeau, A.; Rovis, T. *Angew. Chem. Int. Ed.* **2015**, *54*, 13337-13340. *(c) Highly Efficient Stereoselective Catalytic C(sp^3)−H Insertions with Rhodium Donor Carbenoids Generated from Cyclopropenes*, Archambeau, A.; Miege, F.; Meyer, C.; Cossy, J. *Angew. Chem. Int. Ed.* **2012**, *51*, 11540-11544.

Research Topic for the ParisTech/CSC PhD Program

Field: *Chemistry, Physical Chemistry and Chemical Engineering*

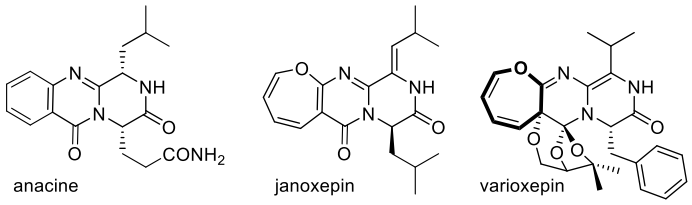
Subfield: Organic chemistry

Title: **Collective total synthesis of quinazoline alkaloids**

ParisTech School: Ecole Polytechnique

Advisor(s) Name: Bastien Nay
Advisor(s) Email: bastien.nay@polytechnique.edu
Lab, website: Laboratoire de Synthèse Organique, https://naygroup.wordpress.com/

Short description of possible research topics for a PhD:
Natural products are an important source of chemical leads for biological purposes. Owing to their limited availability, it is important to design efficient synthetic routes amenable to scale-up for applied perspectives. Among natural products, quinazoline alkaloids are a large class of peptide-derived compounds from fungal origin, possessing a wide variety of biological activities (for example antibiotic, anticancer, phytotoxic). On the structural point of view, their diversity results from various oxidative functionalizations, leading to the hydroxylation or the dehydrogenation of the diketopiperazine ring, or to the conversion of the aromatic part into an oxepin (examples below). All these structural features render the total synthesis of these natural products particularly challenging. This project aims to apply synthetic methodologies already developed in our laboratory to the synthesis of representative natural products of this series, using C-H oxidation and cycloaddition strategies. Collective approaches will allow us to synthesize several quinazoline products in a single divergent synthetic process.



Required background of the student: (Which should be the main field of study of the applicant before applying) The applicant should have a Master degree in organic chemistry and a strong interest in organic synthesis, synthetic methodologies and the biological interface. A good level of spoken and written English is expected.

A list of 5(max.) representative publications of the group: (Related to the research topic)

- M. Zaghouani et al.: Multifaceted study on a cytochalasin scaffold: lessons on reactivity, multidentate catalysis and anticancer properties, *Chem. Eur. J.* **2018**, doi: 10.1002/chem.201804023
- D.-Y. Sun et al.: Asymmetric Total Synthesis of Distaminolyne A and Revision of its Absolute Configuration, *Org. Lett.* **2017**, *19*, 714–717.
- M. Zaghouani et al.: First Total Synthesis, Structure Revision and Natural History of the Smallest Cytochalasin: (+) Periconiasin G, *Chem. Eur. J.* **2016**, *22*, 15257–15260.
- B. Laroche at al.: Ring-closing enyne metathesis of terminal alkynes with propargylic hindrance, *J. Org. Chem.* **2015**, *80*, 5359–5363.
- X.-W. Li et al.: Bio-inspired formal synthesis of hirsutellones A-C featuring an electrophilic cyclization triggered by remote Lewis acid-activation, *Chem. Eur. J.* **2013**, *19*, 16389-16393.

Research Topic for the ParisTech/CSC PhD Program

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry

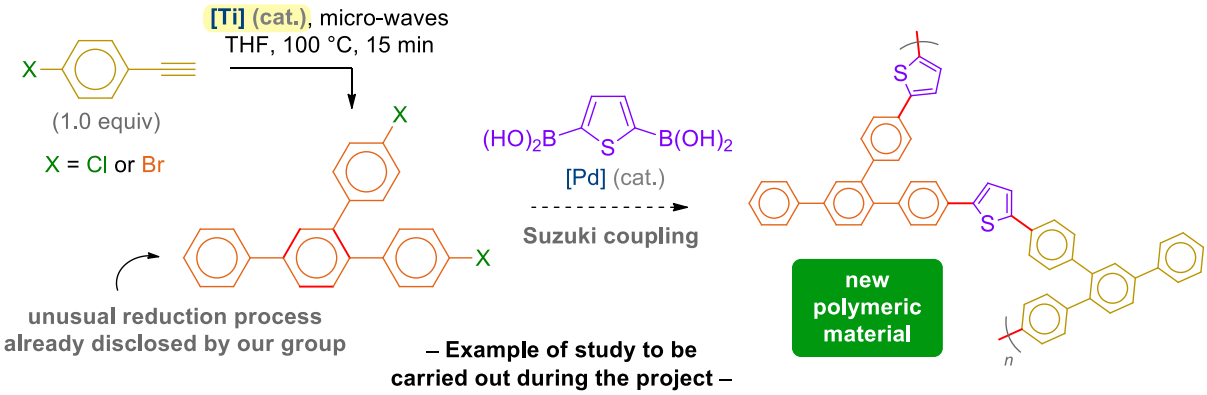
Title: DEvelopMent of the potential Of alkyne-TItanium Complexes (DEMOTIC)

ParisTech School: Ecole Polytechnique

Advisor(s) Name: Dr Yvan Six
Advisor(s) Email: yvan.six@polytechnique.edu
(Lab, website): https://portail.polytechnique.edu/lso/en/research-groups/small-rings-and-organotitanium-chemistry

Short description of possible research topics for a PhD:

The goal of this project is to extend the chemistry of alkyne-titanium complexes, generated using the Ti(O*i*Pr)$_4$/*n*BuLi reagent system, and to develop new applications thereof. Studies will be focused on: (*i*) investigations of new alkyne functionalisation reactions (in particular with CO_2 at standard pressure) and (*ii*) extension of our preliminary work on [2+2+2] cycloaddition processes, with the development of applications towards the synthesis of new materials.



Please note that other research topics are possible as well (see our website): e.g. synthesis of novel endoperoxide compounds with antimalarial activity, cycloaddition reactions from cyclopropane precursors for the synthesis of complex nitrogen-containing systems…

Required background of the student: We are looking for a student having a strong background in organic chemistry, preferably with some experience in polar organometallic chemistry. Some knowledge and interest in material science will also be valued for the project presented above.

A list of 5(max.) representative publications of the group:

- A. Wolan, J. A. Kowalska-Six, H. Rajerison, M. Césario, M. Cordier, Y. Six, *Tetrahedron* **2018**, *74*, 5248−5257. ("Barton Centennial Symposium in Print" special issue)
- V. A. Rassadin, E. Nicolas, Y. Six, *Chem. Commun.* **2014**, *50*, 7666–7669.
- F. Hermant, E. Urbańska, S. Seizilles de Mazancourt, T. Maubert, E. Nicolas, Y. Six, *Organometallics* **2014**, *33*, 5643–5653. ("Catalytic and Organometallic Chemistry of Earth-Abundant Metals" special issue)
- E. Augustowska, A. Boiron, J. Deffit, Y. Six, *Chem. Commun.* **2012**, *48*, 5031–5033.
- C. Madelaine, Y. Six, O. Buriez, *Angew. Chem. Int. Ed.* **2007**, *46*, 8046–8049.

Research Topic for the ParisTech/CSC PhD Program

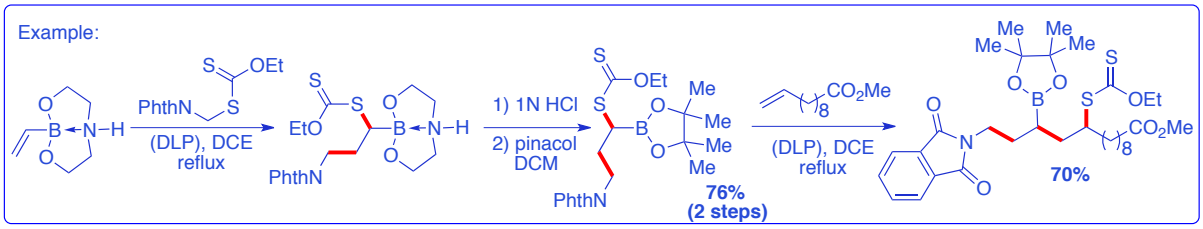
Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Chemistry

ParisTech School: LSO, Ecole Polytechnique

Title: New Routes to Organoboron Derivatives and to Functional Polymers

Advisor: Prof. Samir Z. ZARD
E-mail: samir.zard@polytechnique.edu;
https://portail.polytechnique.edu/lso/en

Short description of possible research topics for a PhD:
The reversible transfer of dithiocarbonates (xanthates) is a uniquely powerful tool for the creation of carbon-carbon bonds. Xanthates reversibly store reactive radicals in a dormant form, thus significantly extending their lifetime while at the same time regulating their absolute and relative concentrations. This allows *intermolecular* radical additions even to unactivated alkenes (see example below). We propose to exploit the properties of xanthates to construct novel medicinally relevant boron heterocycles and study at the same time the little-known chemistry of α-boryl radicals. Organoboron compounds have recently acquired a dramatic importance in medicinal chemistry (e. g. Tavaborole or Kerydin®; Bortezomib or Velcade®). This chemistry will also be applied to create a new family of boron containing polyamides that mimic natural hair in their ability to form disulfide bridges reversibly and to generate double and treble pronged self-healing polymeric hydrogels by modifying existing polymers. Practical applications include adhesives, hair care, surface treatment, modification of cellulose fibres, anticorrosion and anti-graffiti paints, heavy metal recovery, slow release of actives, etc.



Required background of the student: General Organic Chemistry

A list of representative publications of the group:
1. *A Highly Stereoselective, Modular Route to (E)-Vinylsulfones and to (Z)- and (E)-Alkenes*. Braun, M.-G.; Quiclet-Sire, B.; Zard, S. Z. *J. Am. Chem. Soc.* **2011**, *133*, 15954-15957.
2. *From a Remarkable Manifestation of Polar Effects in a Radical Fragmentation to the Convergent Synthesis of Highly Functionalized Ketones*. Debien, L.; Zard, S. Z. *J. Am. Chem. Soc*. **2013**, *135*, 3808-3811.
3. *Radical Instability in Aid of Efficiency. A Powerful Route to Highly Functional MIDA Boronates.* Quiclet-Sire, B.; Zard, S. Z. *J. Am. Chem. Soc.* **2015**, *137*, 6762-6765.
6. *A Radical Bidirectional Fragment Coupling Route to Unsymmetrical Ketones*. Anthore-Dalion, L.; Liu, Q.; Zard, S. Z. *J. Am. Chem. Soc.* **2016**, *138*, 8404-8407.
5. *The Xanthate Route to Ketones. When the Radical is Better than the Enolate*. Zard, S. Z. *Acc. Chem. Res.* **2018**, *51*, 1722-1733.

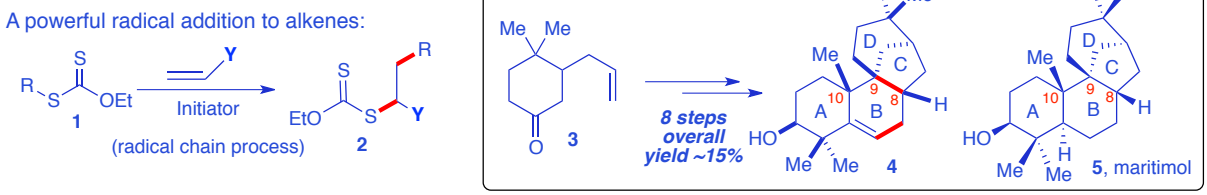
Research Topic for the ParisTech/CSC PhD Program

Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Chemistry
ParisTech School: LSO, Ecole Polytechnique

Title: A Unified Route to Polycyclic Terpenes

Advisor: Prof. Samir Z. ZARD
E-mail: samir.zard@polytechnique.edu;
https://portail.polytechnique.edu/lso/en

Short description of possible research topics for a PhD:
Of all the natural products, terpenes offer the greatest skeletal variety and complexity. Several members, either in native form or as simple derivatives, are already in clinical use (e. g. taxol, Taxotere®, Ingenol mebutate or Picato®, pleuromutilin). Many contain fused or bridging 4, 5, 6, 7- and even 8-membered rings and constitute major synthetic challenges.
Our group has discovered a remarkably powerful reaction involving a xanthate transfer with a *unique ability to* ***store*** *reactive radicals in a dormant form* and thereby to enhance their lifetime in a concentrated medium, while at the same time regulating their absolute and relative concentrations. It allows *intermolecular* radical additions even to unactivated alkenes (**1**→ **2**) and promotes otherwise sluggish processes such as 5-*endo*, 6-*exo*, 6-*endo*, 7-*endo* and 8-*endo* cyclizations. In the present proposal, we would like to develop a unified and particularly concise approach to polycyclic terpenes. Preliminary results are extremely promising, as demonstrated by the synthesis of maritimol (**5**) analog **4** from simple allylcyclohexanone **3** *in only 8 steps*. This is by far the shortest route to such complex terpenoids. It is hoped to extend this powerful strategy to numerous other terpene structures with various combinations and arrangement of rings and ring sizes.



Required background of the student: General Organic Chemistry

A list of representative publications of the group:
1. *A Highly Stereoselective, Modular Route to (E)-Vinylsulfones and to (Z)- and (E)-Alkenes*. Braun, M.-G.; Quiclet-Sire, B.; Zard, S. Z. *J. Am. Chem. Soc.* **2011**, *133*, 15954-15957.
2. *From a Remarkable Manifestation of Polar Effects in a Radical Fragmentation to the Convergent Synthesis of Highly Functionalized Ketones*. Debien, L.; Zard, S. Z. *J. Am. Chem. Soc*. **2013**, *135*, 3808-3811.
3. *Radical Instability in Aid of Efficiency. A Powerful Route to Highly Functional MIDA Boronates.* Quiclet-Sire, B.; Zard, S. Z. *J. Am. Chem. Soc.* **2015**, *137*, 6762-6765.
6. *A Radical Bidirectional Fragment Coupling Route to Unsymmetrical Ketones*. Anthore-Dalion, L.; Liu, Q.; Zard, S. Z. *J. Am. Chem. Soc.* **2016**, *138*, 8404-8407.
5. *The Xanthate Route to Ketones. When the Radical is Better than the Enolate*. Zard, S. Z. *Acc. Chem. Res.* **2018**, *51*, 1722-1733.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): 2. Chemistry, Physical Chemistry and Chemical Engineering
Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…): Chemistry
Title: **Functionnalized nanomaterials for gas sensing**
ParisTech School: Interface
Advisor(s) Name: Fatima Zahra Bouanis
Advisor(s) Email: fatima.bouanis@ifsttar.fr & Tel: +33 (0)1 81 66 84 28
(Lab, website): https://portail.polytechnique.edu/lpicm/en

Environmental monitoring is required to protect the public and the environment from toxic contaminants and pathogens that can be released into a variety of media including air, soil, and water. Moreover, the global environmental monitoring market is poised to grow at a CAGR of 7.5% during 2015-2020, and is expected to reach a value of ~$20.5 Billion in 2020 [1]. As an example: The air segment in the environmental sensing and monitoring market is anticipated to reach USD ~7.7 billion by the end of 2019. This augmentation is driven by different factors such as the massive scale of urbanisation and population growth, development of policies to reduce water, soil and air pollutants and the increase of monitoring environmental stations. **In this framework, the development of low-cost, easy-to-use, miniaturized, portable and long-term monitoring of environmental sensors allowing accurate measurements of air pollutants is needed**.

Nanomaterials such as carbon nanotubes, graphene and transition metal dichalcogenides (TMDs), such as MoS_2 or WS_2, $MoSe_2$ as well as black phosphorus (also known as phosphorene) are one of the best promising candidates for the future development of nanosensors applications[2-3]. This originates from their high surface area (dense number of adsorption sites), high electrical conductivities and low electrical noise (a small change in carrier concentration induced by gas exposure induces significant changes in electrical conductivity), as well as appropriate band gap opening (that can be tuned by the number of the layers in the case of TMDs) [4-6]. In addition, carbon nanotubes and 2D materials can be operated at room temperature, which is impossible in metal oxide semiconductors [8]. In this thesis, we will develop **a reliable and selective new generation of gas sensors based on nanomaterials, based on carbon nanotubes or on 2D materials, that will be used to detect and quantify sensitively and selectively air pollutants (NOx and CO for example) in various environments.**

Required background of the student:

- Master in materials sciences or chemistry or physical chemistry.
- Strong background in nanomaterials.
- Skills in microstructural and spectroscopic characterization techniques is preferred.
- Applicants must be self-driven and highly motivated.
- Excellent interpersonal and communication skills.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1- P. Bondavalli, P. Legagneux and ***D. Pribat***, "CNTFET based gas sensors: state of the art and critical review", *Sensors and Actuators B*, **140**, 304 (2009).

2- ***Fatima. Bouanis***, Costel S. Cojocaru, Vincent Huc, Evgeny Norman, Marc Chaigneau, Jean L. Maurice, Talal Mallah, Didier Pribat,. " Direct synthesis and integration of individual, diameter-controlled SWNTs " *Chem. Mater.*, 2014, **26** (17), pp 5074–5082

3- P. Bondavalli, L. Gorintin, G. Feugnet, G. Lehoucq and ***D. Pribat***, "Selective gas detection using CNTFET arrays fabricated using air-brush technique, with different metals as electrodes", *Sensors and Actuators B: Chemical***, 202**, 1290 (2014).

4- G. Magadur, J.S. Lauret, G. Charron, ***F. Bouanis***, E. Norman, V. Huc, C.S. Cojocaru, S. G Coca, E. Ruiz, T. Mallah. "Charge transfer and tunable ambipolar effect induced by assembly of Cu(II) binuclear complexes on carbon nanotube field effect transistor devices. *J. Am. Chem. Soc.*, 2012, **134** (18), 7896–7901.

5- Gurvan Magadur, ***Fatima Bouanis***, Evgeny Norman, Régis Guillot, Jean-Sébastien Lauret, Vincent Huc, Costel-Sorin Cojocaru and Talal Mallah. « Electrical-field-induced structural change and charge transfer of lanthanide–salophen complexes assembled on carbon nanotube field effect transistor devices. *Chem. Comm.*, 2012, 48, 9071-9073.

Bibliography:

[1] http://www.marketsandmarkets.com

[2] M. Meyyappan, Carbon Nanotubes: Science and Applications, CRC Press, Boca Raton, Fla, USA.

[3] S. Cui et al. *Nature Communications,* 6, DOI: 10.1038/ncomms9632.

[4] Q. H. Wang et al. *Nat. Nanotechnol.,* 7 (2012) 699.

[5] H. Li et al. *Nat. Mater.,* 15 (2016) 48.

[6] G. Lu et al. *J. Chen , Nanotechnology*, 20 (2009) 445502.

Research Topic for the ParisTech/CSC PhD Program

Field: *Chemistry*

Title: Luminescent materials with controlled emission

***ParisTech School*:** Sciences Chimiques : Molécules, Matériaux, Instrumentation et Biosystèmes (2MIB).
Advisor(s) Name: Gaël ZUCCHI
Advisor(s) Email: gael.zucchi@polytechnique.edu
(Lab, website): https://portail.polytechnique.edu/lpicm/en

Short description of possible research topics for a PhD:

We have developed in the last years a series of polymeric materials that show emission in the visible range. The interest in such materials is motivated by the possibility to tune their emission color thanks to a judicious molecular design and their easiness of processing. A family of new monomeric units that had not been employed before have been introduced and their chemistry has been developed. Very promising preliminary results have been obtained, as we have shown that they could lead to polymers with efficient controlled luminescence and increased photostability.
Not only the synthesis of the materials will be done, but their photophysical (absorption and emission) properties will be studied and the polymers will also be investigated as a new generation of phosphors for LED lighting. They will be coated on near-UV LEDs (see figure) and the performance of the resulting lighting systems will be studied in terms of efficiency, color quality, and photo- and thermal stability.
This pluridisciplinary project will give the selected candidate a strong knowledge in chemical synthesis, spectroscopy, elaboration and characterization of lighting systems. He/she will have a broad overview on the design and synthesis of innovative materials and how they can be processed and used in real applications thanks to their specific properties.

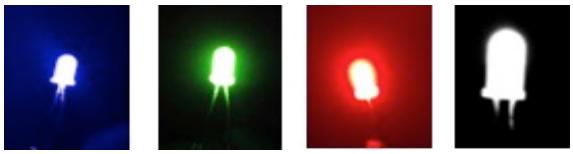


Figure. Near-UV LEDs coated with luminescent polymers.

Required background of the student: The expected candidate will hold a Master Degree in organic/molecular chemistry and will show a strong interest in developing a multidisciplinary project.

A list of 5(max.) representative publications of the group:
- S. Feuillastre, M. Pauton, L. Gao, A. Desmarchelier, A. J. Riives, D. Prim, D. Tondelier, B. Geffroy, G. Muller, G. Clavier, G. Pieters, *J. Am. Chem. Soc.*, **2016**, *138*, 3990–3993.
- X. Huang, G. Zucchi, J. Tran, Robert B. Pansu, A. Brosseau, B. Geffroy, F. Nief, *New J. Chem.*, **2014**, *38*, 5793-5800.
- A. Sergent, G. Zucchi, M. Chaigneau, R. Pansu, D. Tondelier, B. Geffroy, M. Ephritikhine, *J. Mater. Chem. C* **2013**, *1*, 3207-3216.
- G. Zucchi, V. Murugesan, D. Tondelier, D. Aldakov, F. Yang, P. Thuéry, M. Ephritikhine, B. Geffroy, *Inorg. Chem.* **2011**, *50,* 4851-4856.

Research Topic for the ParisTech/CSC PhD Program

Field: Applied Physics
***Subfield*:** Chemistry

ParisTech School: Ecole polytechnique

Title: Synthesis of catalysts for hydrogen fuel cells coupled with silicon nanowire solar cells

Advisor(s): Gael Zucchi, Martin Foldyna
Advisor(s) Email: gael.zucchi@polytechnique.edu; martin.foldyna@polytechnique.edu,
(Lab, website): https://portail.polytechnique.edu/lpicm/en

Short description of possible research topics for a PhD: Production of hydrogen fuel with the assistance of solar energy attracts a lot of attention today because of the ongoing reduction of fossil fuel resources and their inherent pollution. Hydrogen production assisted by solar energy promises a renewable source of fuel which offers a complete energy circle, where water is a source of fuel as well as the byproduct of the hydrogen combustion.
In order to achieve efficient hydrogen fuel production, we aim at developing solar cells that will feed in energy a fuel cell to obtain an autonomous system. Particularly, this proposal proposes to develop silicon nanowire solar cells which can provide high open-circuit voltage in the tandem configuration and large surface areas for more efficient catalysis. They will be fabricated by a low-cost plasma enhanced chemical vapor deposition technique. Based on our experience of carbon nanotubes functionalization, the project also proposes to develop new carbon electrodes made of carbonaceous materials functionalized with metallic nanoparticles that will serve as catalysts for water splitting.
This multidisciplinary work includes i) the synthesis and characterization of catalytic materials; ii) the elaboration of tandem silicon nanowire solar cells based on a combination of materials comprising Si and Ge; iii) the characterization of the devices as far as hydrogen production is concerned.

Required background of the student: Student is required to have a good background in material science with a strong will to develop a multidisciplinary project. Very good communication skills in English and ability to work in team are also required. Motivation of the student to learn a wide variety of techniques will be considered as the most important criterium for selection. Enthusiasm towards renewable energy, solar cells and storage is highly appreciated.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

- S. Misra, L. Yu, M. Foldyna, P. Roca i Cabarrocas, *Solar Energy Materials and Solar Cells* **118**, 90 (2013).
- S. Misra, L. Yu, W. Chen, M. Foldyna, P. Roca i Cabarrocas, *Journal of Physics D: Applied Physics* **47**, 393001 (2014).
- S. Misra, L. Yu, M. Foldyna, P. Roca i Cabarrocas, *IEEE Journal of Photovoltaics* **5**, 40 (2015).
- A. S. Togonal, M. Foldyna, W. Chen, J. X. Wang, V. Neplokh, M. Tchernycheva, J. Nassar, P. Roca i Cabarrocas, Rusli, *Journal of Physical Chemistry C* **120**, 2962 (2016).
- M. Foldyna, A. S. Togonal, Rusli, P. Roca i Cabarrocas, *Solar Energy Materials and Solar Cells* **159**, 640 (2017).

Research Topic for the ParisTech/CSC PhD Program

Field: *Energy, Processes, Materials Science, Physics, Design, Industrialization*

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)

Title: Novel 2D Nanomaterials and hierarchical nanostructures for next generation electronics and optoelectronics

***ParisTech School*:** LPICM-Ecole Polytechnique/ CNRS

Advisor(s) Name: Costel Sorin COJOCARU and Ileana FLOREA

Advisor(s) Email: costel-sorin.cojocaru@polytechnique.edu; and

lenuta-ileana.florea@polytechnique.edu , telephone: +33 1 69 33 43 89

(Lab, website): https://portail.polytechnique.edu/lpicm/en

Short description of possible research topics for a PhD:

One of the hottest topics in materials science, focus nowadays on the 2D layered materials and particularly the possibility of stacking them on top of each other, thus obtaining various 2D heterostructures with new properties, generating a new family of hybrid materials. Recent advances have shown that combining two or more thin layer materials together can generate interfaces with properties significantly different from that of a single component. Particularly, vertically stacked TMDs heterostructures can result in band alignment that facilitates efficient electron-hole separation, and thus enabling fast charge transfer for advanced applications like photodetectors, photovoltaics and light emitting diodes etc. The aim of the thesis project is the development of an original in-place synthesis process of new 2D- materials and their heterostructures for applications in the field of next generation electronics and opto-electronics. The project articulates around three main topics: i) development of new routes for in-place synthesis and characterization of new 2D transition metal dichalcogenides (TMDCs) nanomaterials with tailored properties in the form of M Y2(1-x)Y'2x with M = W and Y,Y' = S, Se, ii) bottom-up assembly and characterization of new 2D-heterostructures and iii) integration of such nanostructures into optoelectronic devices (photo-detectors, transistors…..). The original approach of the project relates to the usage of FENIX equipment (Facility for Elaboration of Nanomaterials with In-situ analysis at X), an unique platform for synthesis and characterization of nanomaterials that Thématiques /Domaine /Contexte Objectifs Méthode enables the in-situ, real time monitoring by surface analysis (angle resolved XPS, UPS, high resolution Auger spectroscopy and reflection low energy EELS), as well as high resolution LEED and mass/ion energy spectroscopy. With the simultaneous availably of more than 8 various (vapors, free radicals, ions) focused matter beams this facility allow future breakthroughs on understanding the growth mechanisms of ultrathin 2D materials and heterostructures, their doping, surface interactions or defects creation.

K. Novoselov, et al. Nature 438 (2005) 197 ;
L.F. Mattheis, Phys. Rev. B 8 (1973) 3719 ;
F. Xia, et al. Nat. Photonics 8 (2014) 899 ;
K. Novoselov, et al. Proc. Natl Acad. Sci. USA 102 (205) 10451 ;
A.K. Geim, et al. Nature 499 (2013) 419

Required background of the student:

We are seeking an excellent young scientist, eager to carry out leading edge research in a multidisciplinary field at interface of materials science, surface science and nano(opto)electronics. The candidate should have a good background in condense matter physics. He (she) will work in strong interaction with a multi-disciplinary team made up of physicists, chemists and engineers.

Research Topic for the ParisTech/CSC PhD Program

Field: *Energy, Processes, Materials Science, Physics, Design, Industrialization*

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)

Title: Hierarchically assembled nanostructures for energy and environmental sustainability applications

ParisTech School: *LPICM-Ecole Polytechnique/ CNRS*
Advisor(s) Name: Costel Sorin COJOCARU and Ileana FLOREA
Advisor(s) Email: costel-sorin.cojocaru@polytechnique.edu; lenuta-ileana.florea@polytechnique.edu , telephone: +33 1 69 33 43 89
(Lab, website): https://portail.polytechnique.edu/lpicm/en

Short description of possible research topics for a PhD:

The effect of global warming as a consequence of continuous consumption of energy resulted from burning of fossil fuels, raised the challenge for both fundamental and industrial research to find sustainable solutions to tackle the problem, with emphasis on topics related to the energy storage devices like supercapacitors, Li-ion and/or Na-ion batteries, and on the photocatalytic reduction of CO2 and H2 production. A raising hot topic in the field of new advanced materials for energy applications, focus on the Transition Metal Dichalcogenides (TMDCs) in nanostructured form that receive a still increasing attention as potential candidates for applications in the area of energy storage and nanocatalysis.*[L. Peng, et al. Adv Energy Mat. 6 (2016) 1600025]*. For Electrochemical Energy Storage devices (as for example Li-ion batteries), depending on their chemical composition, TMDCs can be used either as cathode or anode material and exhibit theoretical specific capacities larger than the commercially available graphite anode or transition layered metal oxides *[H. Hwang, et al. Nano Lett. 11 (2011) 4826]*. At the same time their large interlayer Van der Waals gaps allow the intercalation of Li ions (or larger size Na ions for use in Na-ion batteries) in their structure alleviating the large volume expansion presented in common alloying type materials. However this area of research is still in its infancy and extensive studies need to be pursued for improving the light harvesting and the conversion efficiency in 2D layered TMDs as well as further understanding of the complex photocatalytic mechanism on these materials. The goal of this thesis project is to develop hierarchically assembled nanostructures in forms of electrodes based on dense, thin walled carbon nanotubes (CNTs) carpets used as current collectors and decorated with various TMDC nanomaterials. The role of the CNTs is to: i) increasing the specific electrode surface area ii) insure the fast charge transfer and III) promote good crystallinity of the deposited active material. The functionalization of vertically aligned CNT by TMDs offers an unprecedented opportunity for their use in energy storage devices and photocatalytic reactions. These hierarchical nanoarchitectures, due to their unique combination of redox chemistry, rapid ionic-transport channels, short-distance interactions between charge carriers, as well as between carriers and ions, and their earth-abundance, will play a key role in the successful implementation in the area of rechargeable batteries, photocatalytic water splitting and environmental sustainability applications.

Required background of the student: We are seeking an excellent young scientist, eager to carry out leading edge research in a multidisciplinary field at interface of materials science, surface science and electrochemistry. The candidate should have a good background in (electro) chemistry and/or condensed matter physics. He (she) will work in strong interaction with a multi-disciplinary team made up of physicists, chemists and engineers.

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): 2
Subfield: Surface chemistry and polymers

Title: **Bio-inspired silicon surfaces for anti-biocontamination properties**

ParisTech School: Ecole Polytechnique (LPMC), Palaiseau
Advisor(s) Name: Dr. Anne Chantal Gouget (anne-chantal.gouget@polytechnique.edu ; https://pmc.polytechnique.fr/spip.php?article525&lang=en)
and Prof. Philippe Roger (philippe.roger@u-psud.fr ; http://www.icmmo.u-psud.fr/Labos/LGMM/LSB/)

Short description of possible research topics for a PhD: Biocontamination is of great concern in a wide range of applications, including biomedical implants, food packaging, biosensors or industrial equipment. A reduction of these surface contaminations is pivotal, notably to prevent risks of infection or diseases for human beings. The objective of the thesis is specifically designed to treat and functionalize surfaces to eliminate pathogenic or unwanted biocontamination. Our first goal is to fully control the conception of reproducible green coatings consisting of the growth by ATRP (Atom Transfer Radical Polymerization) of polymer chains obtained from renewable resources (carbohydrates, essential oils or biomass extracts) onto model crystalline silicon substrates. These surfaces will allow an absolute quantification of the molar fraction of comonomers by FTIR spectroscopy in order to establish antibacterial activity criteria. Microbiologic tests will be performed by using pathogenic Gram-positive and Gram-negative bacteria. The second goal of this project is to transfer these grafting protocols developed on crystalline silicon onto various surfaces, like titanium, polymers, steel, for the design of new well-controlled surfaces adapted to the anti-biocontamination properties.

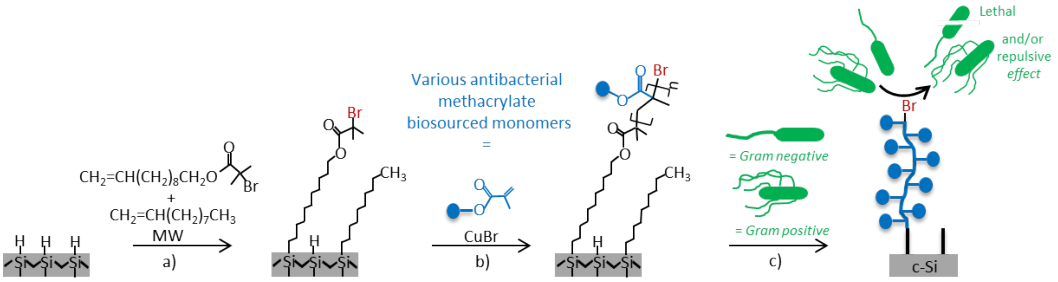


Figure. Silicon functionalization of bio-inspired polymers and antibacterial tests

Required background of the student: strong background in organic chemistry and material chemistry

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. A. Faucheux et al., Well-defined carboxyl-terminated alkyl monolayers grafted on H-Si(111) : Packing density from a combined AFM and quantitative IR study. *Langmuir*, **2006**, 22, 153-162.
2. J. Yang et al., Quantitative assessment of the multivalent protein-carbohydrate interactions on silicon. *Analytical Chemistry*, **2014**, 86, 10340-10349.
3. S. Bedel et al., Antibacterial surfaces obtained from thymyl methacrylate polymerization. *Journal of Polymer Science Part A - Polymer Chemistry*, **2015,** 53, 1975-1985.
4. M. Maaz et al., Surface initiated supplemental activator and reducing agent atom transfer radical polymerization (SI-SARA-ATRP) of 4-vinylpyridine on poly(ethylene terephthalate). *Journal of Colloid and Interface Science*, **2017**, 500, 69-78.

Research Topic for the ParisTech/CSC PhD Program

Field:	2.Chemistry, Physical Chemistry and Chemical Engineering
Subfield:	8. Materials Science, Mechanics, Fluids
Title:	**Paramagnetic analysis inside diamagnetic nanoparticles by NMR relaxation**
ParisTech School:	École polytechnique
Advisor(s) Name:	MARON Sébastien; GACOIN Thierry
Advisor(s) Email:	sebastien.maron@polytechnique.edu; thierry.gacoin@polytechnique.edu
(Lab, website):	Laboratoire de Physique de la Matière Condensée https://pmc.polytechnique.fr/spip.php?article623

Short description of possible research topics for a PhD:
A vast majority of functional materials have physical properties (optical, magnetic or transport) whose origin comes from the presence of doping elements. Often present in small quantities, their precise characterization in terms of distribution, oxidation state or other, is a major difficulty in materials science and the development of adapted experimental techniques is an important subject. On this theme, the laboratory has been working for some years on the use of solid-state nuclear magnetic resonance (NMR), notably by seeking to use paramagnetic dopant induced relaxation effects. Beyond the methodological aspect, this subject is treated in connection with our activities in the field of luminescent nanoparticles, whose properties result from the insertion of rare earths into the crystalline matrix. These particles are of great interest in the field of probes for biology, in microfluidics, or for lighting or display devices...

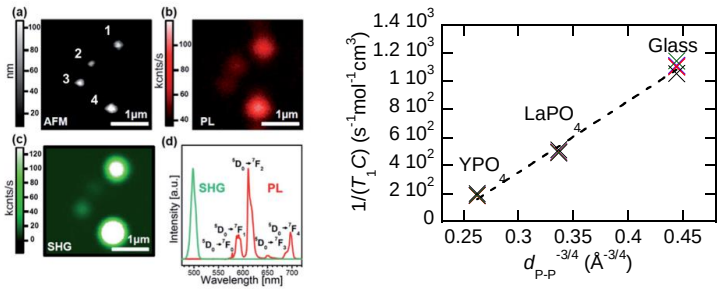


Figure 1: LEFT – Application of a kind of nanoparticle (here: KTP@$LaPO_4$:Eu). For more details, see Mayer et. al DOI: 10.1039/c4tc01227e. RIGHT - Determination of Nd^{3+} concentration *C* in different phosphorus materials.

Previously, we have shown that, whatever the massive material, crystalline or not, the longitudinal relaxation rate $1 / T_1$ being linear with the doping rate, there exists a law connecting the concentration in dopant C, T_1 and the average distance between each nucleus probed by the NMR experiment (^{31}P here), $d_{P\text{-}P}$. After having developed this law on massive materials, we now want to implement it on nanoparticles which we control the synthesis, especially $LaPO_4$ monazite phase. This monoclinic phase of lanthanum phosphate is of interest, unlike the hexagonal phase, to have no proton.

Required background of the student: Solid-State Chemistry; Solid-State NMR

A list of 5(max.) representative publications of the group:
Maron, S. *et al*. DOI: 10.1039/C4CP02628D
Maron, S. *et al*. DOI: 10.1039/C7CP00451F

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):***

Mathematics and their applications, and Life and Health Science and Technology

Subfield: Medical imaging

Title:Enabling Cortical Cell-Specific Sensitivity on Clinical Multi-shell diffusion MRI Microstructure Measurements

ParisTech School:Ecole Polytechnique, Inria-Saclay

Advisor(s) Name: Demian Wassermann, Jing-Rebecca Li
Advisor(s) Email:Demian Wassermann (http://pages.saclay.inria.fr/demian.wassermann), Jing-Rebecca Li (http://www.cmap.polytechnique.fr/~jingrebeccali).
(Lab, website):This project is a close collaboration between a) the Parietal team (http://team.inria.fr/parietal) b) the Defi team (http://www.cmap.polytechnique.fr/~defi/) from INRIA (https://www.inria.fr/en/) and Ecole Polytechnique (https://www.polytechnique.edu/en), and c) Stanford Cognitive and Systems Neuroscience Laboratory, USA (http://med.stanford.edu/scsnl.html).

Short description of possible research topics for a PhD:
The proposed project attacks a new frontier of*in-vivo* microscopy through diffusion magnetic resonance imaging (dMRI). We propose a project on the edge of MR physics, machine learning, and human cyto-architecture by using dMRI for microstructure quantification, focusing on heterogeneous cellular tissue. There has been tremendous progress made in the past decades in axonal tracking and axonmicrostructure quantification in the human brain. The study of such problems in the human brain's white matter, which is composed of mostly axons, is facilitated by the cylindrical nature of the bundled axons. Such "simple" structure, unfortunately, is a particular characteristic of the white matter. The multiple-scale and anisotropic nature of general tissuecellular architecturemakes the microstructure quantification problem much more difficult in other areas of the brain.However, in an exciting preliminary work, we have shown that using multiple shell dMRIacquisitions has the potential to give quantitative information about cellular populations in tissue containing Von Economo neurons (VEN).In this PhD project, we will use numerical, analytical, and machine learning techniques to simulate and analyze the dMRI signal and design acquisition protocols to perform dMRI-based *in-vivo* non-invasive microscopy of the human brain.

Required background of the student:
The desired profile is someone who has obtained a Master's degree in Applied Mathematics or Computer Science and has the ability to program in Matlab or Python. This candidate should have a good level of understanding of methods of numerical solution of partial differential equations and the physics of diffusion.

A list of 5(max.) representative publications of the group: (Related to the research topic)
1.Wassermann D, Nguyen VD, Gallardo-Diez G, Li J-R, Cai W, Menon V (2018) *Sensing Spindle Neurons in the Insula with Multi-shell Diffusion MRI*, ISMRM.
2.O'Donnell LJ, Daducci A, Wassermann D, Lenglet C (2017) *Advances in computational and statistical diffusion MRI*. NMR in Biomedicine e3762:e3805. doi: 10.1002/nbm.3805
3. Haddar, Li, Schiavi (2017)*Understanding the time-dependent diffusion tensor measured by diffusion MRI: the intra-cellular case.* SIAM Journal of Applied Mathematics.
4. Nguyen, Li, Grebenkov, Le Bihan.(2014) *A finite elements method to solve the Bloch-Torrey equation applied to diffusion magnetic resonance imaging*.Journal of Computational Physics.

Research Topic for the ParisTech/CSC PhD Program

1. ***Field :*** Information and Communication Sciences and Technologies
2. ***Subfield***: Computer Science

Title: *Graph of symbols and degeneracy for genomic data*

ParisTech School: Ecole Polytechnique

Advisor(s) Name: Mireille Régnier
Advisor(s) Email: *Mireille.regnier@polytechnique.edu*
(Lab, website): *https://www.lix.polytechnique.fr/*

Short description of possible research topics for a PhD:

Genomic data are very diverse with potentially lots of errors and uncertainty including sequencing errors and mutations.
These issues are the grounds of a research at LIX on Information Retrieval and Text Mining. Graph of words methods, defined by M. Vazirgiannnis and colleagues [1, 2] have been extremely successful in text mining that presents significant analogies to genome. We plan to employ advanced techniques based on word enumeration and combinatorics and developed by M. Régnier [3] to estimate size and also stability properties.

More specifically we will capitalize on the graph of words methods to create graphs of symbols from biological sequences data aiming at creating dense structures that employ the biological significance of the sequences. The graph of words method is very robust with regards to maintaining infomration theory related metrics (reducing the initial coding entropy in the graph structure) and the robustness of this data structure for degenerated genomic data will be studied. One should consider in turn uncertainty due to evolution, to directed evolution and to sequencing errors. Moreover we will employ and validate on such specific data the graph degeneracy technique (a computationally feasible method) to approximate the densest genome graph that apparently has significant properties.

Required background of the student:

Background should be in computer science, with strong skills in algorithms.
As an alternative, a background in combinatorics, with solid knowledge on algorithms, would fit.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. Rousseau, F. and M. Vazirgiannis. *Graph-of-word and TW-IDF: new approach to ad hoc IR*. in *22nd {ACM} International Conference on Information and Knowledge Management, CIKM'13, San Francisco, CA, USA, October 27 - November 1, 2013*. 2013. {ACM}.
2. Meladianos, P., et al. *Degeneracy-Based Real-Time Sub-Event Detection in Twitter Stream*. in *Proceedings of the Ninth International Conference on Web and Social Media, {ICWSM} 2015, University of Oxford, Oxford, UK, May 26-29, 2015*. 2015. {AAAI} Press.
3. Regnier, M., et al., *A Word Counting Graph*, in *{London Algorithmics 2008: Theory and Practice (Texts in Algorithmics)}*, J.W.D. Joseph Chan and M.S. Rahman, Editors. 2009, {London College Publications}. p. 31 p.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Computer science, networking

ParisTech School: Ecole Polytechnique

Title: Low power Wide Area Networks for Internet of Things

Advisor(s):
- Thomas Clausen (thomas.clausen@polytechnique.edu http://www.thomasclausen.net)
- Jiazi Yi (jiazi.yi@polytechnique.edu https://jiaziyi.com)
https://www.epizeuxis.net

Short description of possible research topics for a PhD:
Low-Power Wide Area Networking (LPWAN) is a wireless technology poising itself to be to the "Internet of Things" what WiFi was to consumer networking. Unlike other wireless networking technologies such as WiFi, 4G, or Zigbee, LPWANs aim to provide connectivity to particularly power-constrained devices, trading off low data rates (and, possibly asymmetric links) for attaining long range (up to tens of km). Initial emphasis of the project will be the following LPWAN topic areas:

- *The Network Layer* Packet sizes, link asymmetry, delays, etc., makes IPv6 support all the way to the end devices a challenge: in most LPWAN architectures, the "I" in "Internet of Things" is a central server, bridging "the Internet" to a link-adapted communications stack on the "things". New One way to avoid that could be to have end-devices relay information between each other towards a gateway through multi-hop paths with shorter links, and using a higher data rate - **the challenge** being to discover and maintain such multi-hop paths, and to optimize their usage.
- The Data-Link Layer For implementation simplicity, LPWAN technologies often use Aloha as MAC protocol - known to result in inefficient channel usage in traffic-dense networks. A starting point for this can be to explore and adapt 802.15.4 scheduling mechanisms to also leverage LPWAN multi-hop topologies -- e.g. allowing topology-aware time-slot assignment to non-overlapping links.
- Further aspects Based on the findings from the previous topic areas, new challenges are likely to emerge also for upper layers, such as the examples given below: Data forwarding along multi-hop paths consisting of resource-constrained end devices, potentially introduces congestion as a problem to be addressed within the LPWAN - but, likely not by the same methods as were used "across the Internet". For example, part of this problem may be alleviated by a scheduling mechanism, introduced at the Datalink Layer. This may also inspire an entirely different transport semantics (e.g., as in CoAP), presenting a different service set to the application layer, possibly supporting decentralized data processing and/or "light learning" in the edge as a means to reduce network load and response time.

The topic areas mentioned above will be studied by building analytical models to understand theoretical boundaries. Network simulation tools will be used to evaluate protocol performance and simulate large scale scenarios. Real testbeds will be built to validate the correctness of the proposals.

Required background of the student: Computer networks, wireless communication, embedded systems, signal processing, information theory

A list of 5 (max.) representative publications of the group:

[1] Augustin, A.; Yi, J.; Clausen, T.; Townsley, W.M. A Study of LoRa: Long Range & Low Power Networks for the Internet of Things. Sensors 2016, 16, 1466.
[2] Yi, Jiazi; Clausen, Thomas; Herberg, Ulrich. Depth First Forwarding for Unreliable Networks: Extensions and Applications. Internet of Things Journal, IEEE, 2 (3), pp. 199–209, 2015.
[3] Thomas Clausen, Christopher Dearlove, Philippe Jacquet, Ulrich Herberg, IETF Proposed Standard RFC7181: The Optimized Link State Routing Protocol Version 2
[4] Clausen, Thomas; de Verdiere, Axel Colin; Yi, Jiazi; Igarashi, Yuichi; Lys, Thierry; Lavenu, Cedric; Herberg, Ulrich; Satoh, Hiroki; Niktash, Afshin; Dean, Justin. ITU G.9903 Narrow-band orthogonal frequency division multiplexing power line communication transceivers for G3-PLC networks: Amendment 1 -- The Lightweight On-demand Ad hoc Distance-vector Routing Protocol - Next Generation (LOADng)

Research Topic for the ParisTech/CSC PhD Program

Subfield: Computer science, networking

ParisTech School: Ecole Polytechnique

Title: Intelligent High Performance Computer Networks

Advisor(s):
- Thomas Clausen (thomas.clausen@polytechnique.edu http://www.thomasclausen.net)
- Jiazi Yi (jiazi.yi@polytechnique.edu https://jiaziyi.com)
https://www.epizeuxis.net

Short description of possible research topics for a PhD:

The development of cloud computing, "big data" era and streaming of high-resolution video over computer networks triggers the demand of high performance network infrastructure. This PhD project aims at proposing, designing and evaluating new intelligent network algorithms to meet the need of high performance networking. It includes, but not limited to:

- Design efficient and scalable multicast algorithms for high-load traffic (such as video stream).
- Propose flexible load balancing mechanisms to dynamically distribute the traffic and computational load among servers in data centers.
- Study pacing and synchronization methods to meet the requirement of real time traffic (such as live video streaming) processing.
- Implement the self-learning and intelligent algorithms and build prototypes on high performance network platform (such as NetFPGA https://netfpga.org) .

The topic areas mentioned above will be studied by building analytical models to understand theoretical boundaries. Network simulation tools will be used to evaluate protocol performance and simulate large scale scenarios. Real testbeds will be built to validate the correctness of the proposals.

Required background of the student: Computer networks, information theory, solid programming skills

A list of 5 (max.) representative publications of the group:
[1] Desmouceaux, Yoann; Pfister, Pierre; Tollet, Jérôme; Townsley, Mark W; Clausen, Thomas, 6LB: Scalable and Application-Aware Load Balancing with Segment Routing, IEEE/ACM Transactions on Networking, 26 (2), pp. 819-834, 2018, ISSN: 1063-6692.
[2] Desmouceaux, Yoann; Clausen, Thomas; Cordero, Juan Antonio; Townsley, Mark W, Reliable Multicast with B.I.E.R., IEEE/KICS Journal of Communications and Networks (JCN), 20 (2), pp. 182-197,
[3] Yoann Desmouceaux, Sonia Toubaline, Thomas Clausen, Flow-Aware Workload Migration in Data Centers, Journal of Network and Systems Management, October 2018, Volume 26, Issue 4, pp 1034–1057 |

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below): Physics***

Subfield: Applied Physics

Title: Pulsed cold plasmas interacting with liquids

ParisTech School:EcolePolytechnique

Advisor(s) Name: ROUSSEAU Antoine
Advisor(s) Email: Antoine.rousseau@lpp.polytechnique.fr
(Lab, website): www.lpp.fr

Short description of possible research topics for a PhD:
The objective of this thesis is the study of plasmas in water or at the gas / liquid interface. Possible applications of this fundamental work are applications of plasmas to nanomaterial synthesis, water treatment, medicine and agriculture.
This thesis will be mostly experimental and will have several aspects:

i) Understand the physical mechanisms underlying the initiation and propagation of the discharge. This study will be based on rapid imaging and ombroscopy coupled with time-resolved emission spectroscopy to measure plasma parameters during the propagation of the "streamer" in water. Particular attention will be paid to the high pressure conditions (> 100 bar) observed during the first nanoseconds of penetration of the plasma filament into the liquid medium.
ii) Study the plasmas generated in the gas phase at the liquid / gas interfaces. In particular, we want to develop plasmas of a few nanoseconds at high frequencies (10 kHz) and compare them to radiofrequency type plasmas.
iii) Explore the biological and chemical potentialities of micro-discharges in aqueous media.

Required background of the student: Physics, Applied Physics, electrical engineering,

A list of 5(max.) representative publications of the group: (Related to the research topic)

A1. **Non-thermal DBD plasma array on seed germination of different plant species**
Bo Liu, Bruno Honnorat, Hang Yang, Jaime Arancibia, LoicRajjou and Antoine Rousseau
J. Phys. D: Appl. Phys. 52 (2019) 025401

A2. **Charge and energy transferred from a plasma jet to liquid and dielectric surfaces**
M. Dang Van Sung Mussard, E. Foucher, A. Rousseau
J. Phys. D: Appl. Phys. (2015) 48 424003

A3. **The influence of the geometry and electrical characteristics on the formation of the atmospheric pressure plasma jet**
A Sobota, O Guaitella and A Rousseau
Plasma Sources Sci. Technol. 2014 23 025016 doi:10.1088/0963-0252/23/2/025016

A4. **Dynamics of plasma evolution in nanosecond underwater discharge**
Marinov, I; Starikovskaia, Svetlana; Rousseau, Antoine
J. Phys. D: Appl. Phys, 2014, 47 224017, (http://iopscience.iop.org/0022-3727/47/22/224017)

A5. **Time-resolved imaging of nanosecond-pulsed micro-discharges in heptane.**
A. Hamdan, I. Marinov, A. Rousseau and T. Belmonte
J. Phys. D: Appl. Phys, 2014 47 055203 doi:10.1088/0022-3727/47/5/055203

1. ansport

Research Topic for the ParisTech/CSC PhD Program

Field: 8. Material Science; 2. Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Material Science; Chemistry
ParisTech School: ESPCI Paris, 10 Rue Vauquelin, 75005 Paris
***Title**: Upconversion Organic-Inorganic Hybrid Materials for Optoelectronics*
Advisors: Dr. Lionel Aigouy (lionel.aigouy@espci.fr) and Dr. Zhuoying Chen (zhuoying.chen@espci.fr)
Web sites: http://www.espci.fr/recherche/labos/lpem/mnc/index.html, and http://optoelec.lpem.espci.fr

Short description of possible research topics for a PhD:

Photon upconversion, a phenomenon to convert low energy photons into high energy ones, has been a fascinating topic since its discovery. Over the last decades, various upconversion material systems have been identified which can be classified as systems relying on rare-earth elements and systems without rare-earth elements. Concerning rare-earth systems, major examples mainly include fluoride, oxide and oxysulfide matrixes (host) doped or co-doped by trivalent lanthanide cations capable to perform upconversion through a multi-photon absorption by the sensitizer (e.g. Er^{3+}) and subsequent energy transfer to the emitter (e.g. Yb^{3+}, Er^{3+}). By comparison, non-rare-earth systems rely mainly on the energy transfer of excitons from sensitizers (e.g. colloidal quantum dots, tetracene molecules) to the spin-triplet states of annihilators (e.g. ruberene, pentacene) where two triplet excitons on neighbouring molecules interact to generate one higher-energy singlet excited state (i.e. triplet-triplet annihilation). Upconversion materials have many applications in fields including biomedical engineering, optical amplification, thermal sensing, photodetection, night vision, and solar energy harvest [*Nat. Photonics* 10, 31-34 (2015), *Chem. Rev.* 115, 395-465 (2015)]. Currently in our laboratory the synthesis of upconversion nanocrystals (NCs) have been established (Figure 1).

In this thesis, we aim to study a series of upconversion NCs and organic-NC hybrids for optoelectronic applications such as photovoltaic devices and photodetectors. Both rare-earth and non-rare-earth routes will be studied in order to obtain the best upconversion systems for the targeted application. This project will start with learning the colloidal synthesis for upconversion NCs as well as published synthetic protocols to form NC/organic molecule upconversion hybrids. Structural and optical characterizations will be performed on the obtained upconversion systems. The student will then focus on the design and fabrication of a hybrid photodetector or photovoltaic structure where the upconversion systems will be applied to detect/harvest near-infrared photons (on which the photodetector itself, without upconversion systems, has no sensitivity). Device performance will be characterized in-house providing feedbacks to the material synthesis. In addition to the design of novel photovoltaic and photodetector devices, the obtained upconversion materials will also be used for thermal and plasmonic imaging experiments in nanooptics.

Required background of the student: Materials Science, or Chemistry. Motivated for experiments and good in English.

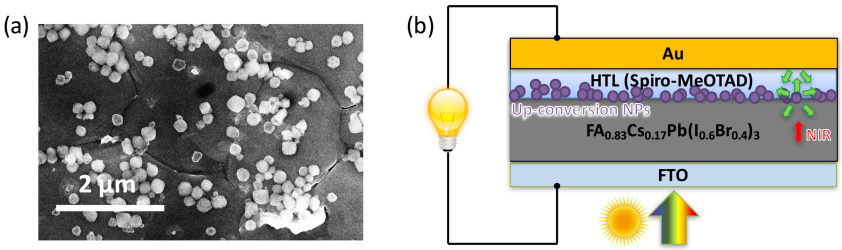


Figure 1. (Left) KY_7F_{22} nanocrystals co-doped with Yb^{3+} and Er^{3+} deposited on $[HC(NH_2)_2]_{0.83}Cs_{0.17}Pb(I_{0.6}Br_{0.4})_3$ perovskite layer. (Right) Schematic describing a photovoltaic device structure applying upconversion nanocrystals in the hole-transport polymer.

2-3 representative publications of the group:

- "Microscopic Evidence of Upconversion-Induced Near-Infrared Light Harvest in Hybrid Perovskite Solar Cells", M. Schoenauer Sebag et al, *ACS Applied Energy Materials*, 1, 3537-3543 (2018)
- "Short-Wave Infrared Sensor by the Photothermal Effect of Colloidal Gold Nanorods", H. Xiang et al, *Small*, 14, 1704013 (2018)
- "Compact layer free mixed-cation lead mixed-halide perovskite solar cells", Z. Hu, *Chem. Comm.* 54, 2623-2626 (2018)

Research Topic for the ParisTech/CSC PhD Program

Subfield: wetting, soft matter physics, physical chemistry

ParisTech School: ESPCI

Title: Magnetic control of wettability on superhydrophobic surfaces

Advisor(s): Etienne Barthel (https://www.simm.espci.fr/spip.php?article806 - etienne.barthel@espci.fr) in collaboration with Jérôme Fresnais (PHENIX, Sorbonne University, http://www.phenix.cnrs.fr/spip.php?article504).

Short description of possible research topics for a PhD:
Superhydrophobic surfaces attract the interest of both academic and industrial research communities for their unique self-cleaning, anti-icing, and non-wetting properties. Such surfaces combining hydrophobicity and roughness, are widely found in nature on plant leaves or animal bodies (feathers or velvets). The main drawback of these surfaces is that the roughness can be corrupted with dust, drastically reducing their durability of their wetting properties. The main countermeasure in nature consists in regeneration of the hydrophobic structures.
This is of course not possible (yet) for synthetic surfaces, **but how simple would be the life of a Lotus leaf if it could actuate the micrometric structures at its surface**? What nature cannot do, we are able to achieve through external stimulation of soft magnetic textures. In a recent PhD work, we have shown that we can control the orientation of magnetic PDMS pillars, and thereby directly act on the wetting properties of a single droplet. This result paves the way to novel surfaces with engineered wetting dynamics, by tuning surface properties, texture morphologies and stiffness, and the dynamics of the externally applied magnetic field. The present project will combine novel surface preparation, magnetic characterization and relatively simple dynamic wetting experiments to establish the surface properties.
These experimental advances will form the basis of an improved understanding of the dynamic wetting on dynamic surfaces. Besides fundamental aspects, the understanding of dynamical wetting of micro- and nano-structured surfaces has numerous applications like nanofluidics, the captation of dew, the control of evaporating solutes like proteins and colloids, …

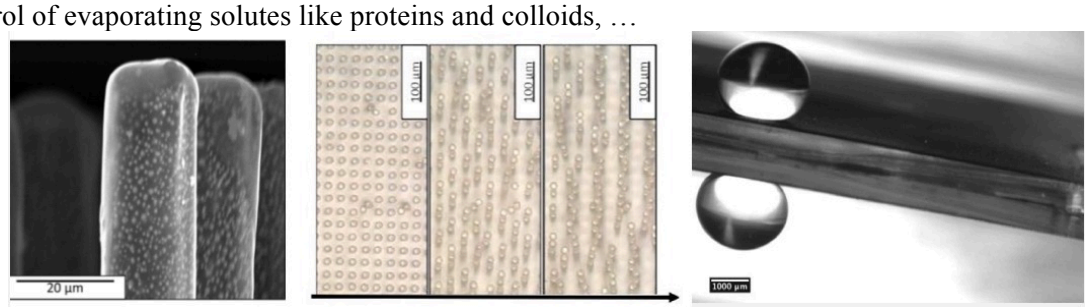


Figure: Soft magnetic pillars / magnetic interactions between pillars / controlled motion of droplet on a tilted superhydrophobic surface

Required background of the student: Interest for physical chemistry or soft matter or polymer/composites formulation – familiarity with wetting or surfaces would be a plus.
Publications of the group:
Le Digabel, J. et al., (2011) *Magnetic Micropillars as a Tool to Govern Substrate Deformations,* Lab on a Chip 11 : 2630.
Gauthier, A. et al. (2013). *Role of kinks in the dynamics of contact lines receding on superhydrophobic surfaces*, Phys. Rev. Lett. 110 : 046101.
Rivetti, M. et al. (2015). *Surface Fraction Dependence of Contact Angles Induced by Kinks in the Triple Line*, Phys. Rev. Lett. 115 : 016101.

Research Topic for the ParisTech/CSC PhD Program

Field: Information and Communication Sciences and Technologies

Subfield: Human Machine Interface

Title: Use of AI Techniques to Improve Ultrasound Based Silent Speech Interfaces

ParisTech School: ESPCI

Advisor(s) Name: Professor Bruce Denby
Advisor(s) Email: bruce.denby@espci.fr
(Lab, website): Langevin Institute, https://www.institut-langevin.espci.fr/bruce_denby

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure) Silent Speech Interfaces, or SSI, that process unvocalized speech in situations where silent communication is required, have been developed in laboratories for several years, yet remain experimental. Recently, significant improvements in SSI performance have been obtained through the application of AI technology to the front-end image processing steps of these systems. The thesis will entail applying the most recent AI techniques, such as Deep Convolutional and Generative Adversarial Networks, to the image processing front-ends of these systems, in order to achieve speech recognition performances allowing SSI to move out of the laboratory and into real world applications. The work will be carried out at the Langevin Institute in Paris, France, using an ultrasound-based SSI acquisition system developed in-house by the pioneering team of Professor B. Denby.

Required background of the student: (Which should be the main field of study of the applicant before applying) The ideal candidate will have top-notch programming skills as well a willingness to invest him or herself in real-time programming environments involving sensor data. Background in image processing and/or machine learning (AI) techniques will be an advantage.

A list of 5(max.) representative publications of the group: (Related to the research topic)

Bruce Denby, Tanja Schultz, Kiyoshi Honda, Thomas Hueber, J. M. Gilbert, Jonathan S. Brumberg, *Silent Speech Interfaces*, Speech Communication, Volume 52, Issue 4, April 2010, Pages 270-287.

Chengrui Wu, Shicheng Chen, Guorui Sheng, Pierre Roussel, Bruce Denby, *Predicting Tongue Motion in Unlabeled Ultrasound Video Using 3D Convolutional Neural Networks*, ICASSP2018, Calgary, Canada, 15-20 April, 2018.

Shicheng Chen, Yifeng Zheng, Chengrui Wu, Guorui Sheng, Pierre Roussel, Bruce Denby, *Direct, Near Real Time Animation of a 3D Tongue Model Using Non-Invasive Ultrasound Images*, ICASSP2018, Calgary, Canada, 15-20 April, 2018.

Yan Ji, Licheng Liu, Hongcui Wang, Zhilei Liu, Zhibin Niu, Bruce Denby, *Updating the Silent Speech Challenge Benchmark with Deep Learning*, Speech Communication, Volume 98, April 2018, Pages 42-50.

Research Topic for the ParisTech/CSC PhD Program

Field : Life and Health Science and Technology
Subfield: Applied physics
Title: Surface motion imaging of human breathing
ParisTech School: ESPCI - Institut Langevin
Advisors' Names:
Ros Kiri-Ing [physics and engineering] ; Thomas Similowski [respiratory medicine]
Advisors' Email:
ros-kiri.ing@espci.fr ; thomas.similowski@upmc.fr
Lab, website
https://www.institut-langevin.espci.fr/people
http://medecine.sorbonne-universite.fr/fr/la_recherche/laboratoires/neurophysiologie-respiratoire-experimentale-et-clinique.html

Short description of possible research topics for a PhD: Measuring human ventilation is a challenge because currently available techniques all induce ventilatory changes. Contactless approaches are therefore desirable. The laboratories involved in this project have developed an airborne ultrasound approach capable of characterizing respiratory movements in a fully ecological context (surface motion camera, SMC). Furthermore, this approach gives access to a regional segmentation of the dynamic behavior of the rib cage, which opens new avenue regarding the diagnosis of respiratory disorders. The PhD involved in this project will participate in experiments aimed at validating the SMC approach in normal individuals and in patients, will participate in the analysis of the corresponding data, and will be involved in the technological progression of the device development. He will be supervised by both physiologists and physicians on one hand, and physicists and engineers on the other hand. More details can be obtained by writing to the advisors, see above.

Required background of the student: The project can welcome either a PhD with a physics and engineering background [who will then be involved in the technical and signal processing aspects of the project] or a PhD with a medicine or physiology background [who will then be involved in human experiments and data analysis]. The ideal would be a student with technical skills in medical imaging and respiratory physiology.

A list of 5(max.) representative publications of the group, related to the research topic:
1. P. Shirkovskiy, A. Laurin, N. Jeger-Madiot, D. Chapelle, M. Fink and R.K. Ing, Airborne ultrasound surface motion camera: application to seismocardiography, accepted for publication in Applied Physics Letters, (2018).
2. Teulier M, Fiamma MN, Straus C, Similowski T. Acute bronchodilation increases ventilatory complexity during resting breathing in stable COPD: toward mathematical biomarkers of ventilatory function? *Respir Physiol Neurobiol* 2013: 185(2): 477-480.
3. Bokov P, Fiamma MN, Chevalier-Bidaud B, Chenivesse C, Straus C, Similowski T, Delclaux C. Increased ventilatory variability and complexity in patients with hyperventilation disorder. *J Appl Physiol (1985)* 2016: 120(10): 1165-1172.
4. Jeger-Madiot N, Gateau J, Fink M, Ing RK. Non-contact and through-clothing measurement of the heart rate using ultrasound vibrocardiography. *Med Eng Phys* 2017: 50: 96-102.
5. Nierat MC, Dube BP, Llontop C, Bellocq A, Layachi Ben Mohamed L, Rivals I, Straus C, Similowski T, Laveneziana P. Measuring Ventilatory Activity with Structured Light Plethysmography (SLP) Reduces Instrumental Observer Effect and Preserves Tidal Breathing Variability in Healthy and COPD. *Front Physiol* 2017: 8: 316.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Applied Physics

ParisTech School: ESPCI Paris (Langevin Institute)

Title: Acoustic monitoring and triggering of avalanches in granular media

Advisor(s)*:* Professors X. Jia (xiaoping.jia@espci.fr) https://www.institut-langevin.espci.fr

Short description of possible research topics for a PhD:
Laboratory studies of granular materials have emerged as a powerful tool for investigating dynamics of seismic faults (Fig. 1a), such as local and remote dynamic triggering of earthquakes [1]. However, the physical origin of dynamic triggering still remains a challenging issue due to small strain amplitude of impinging seismic waves. Advances in granular physics and acoustics lead to the emerging view that dynamic perturbation of sheared granular materials causes a material softening (Fig. 1b) and fault slip that can be considered as unjamming transition (solid-to-liquid states) [2] induced by the acoustic fluidization [3]. Here we investigate the shearing instability along the free surface of granular media, namely avalanches (Fig. 1c) by acoustic probing of precursor events and also study their triggering by impinging elastic waves via nonlinear acoustic pumping. Prior to the shear failure, we will measure the shear wave velocity softening and use the correlation function of the multiply scattered coda waves to monitor the stick-slip like rearrangement of granular networks [4, 5], together with the passive detection of acoustic emission. At the same time, we will study the onset of avalanches triggered far below the static threshold by the acoustic lubrication of the contact area between solid particles [6].

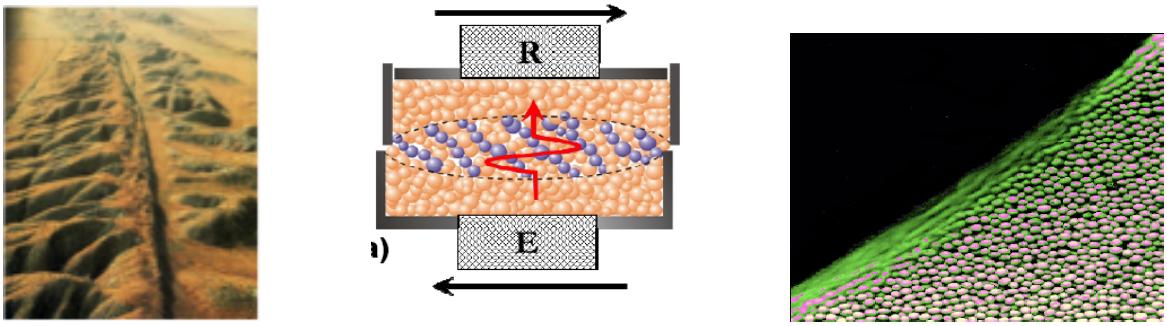


Fig. 1a) San Andreas fault b) Acoustic probing of shear banding c) Granular avalanche

A list of 5 (max.) representative publications of the group: **author(s)** of the group in **bold**
[1] P. Johnson and **X. Jia**, *Nature* 437, 871 (2005)
[2] H. Jaeger, S. Nagel, R. Behringer, *Rev. Mod. Phys*. 68, 1259 (1996)
[3] **X. Jia,** T. Brunet, J. Laurent, *Phys. Rev. E* 84, 020301(R) (2011)
[4] Y. Khidas and **X Jia**, *Phys. Rev. E* 85, 051302 (2012)
[5] **X. Jia**, C. Caroli, B. Velicky, *Phys. Rev. Lett*. 82, 1863 (1999)
[6] J. Léopoldès, **X. Jia**, A. Tourin, A. Mangeney (to be submitted)

Required background of the student: Physics or Acoustics or Mechanics

Research Topic for the ParisTech/CSC PhD Program

Field: Physics, Material Science

Subfield: Physics, Electronic properties of matter, Spintronic

Title: Inducing spin-orbit and exchange interaction in 2-D materials by interface effects

ParisTech School: ESPCI Paris

Advisor(s) Name: Dr. Sergio Vlaic
Advisor(s) Email: sergio.vlaic@espci.fr
(Lab, website): https://qs.lpem.espci.fr/home/

Short description of possible research topics for a PhD: The development of novel materials with non-trivial electronic properties is nowadays a major and competitive research field in condensed matter physics in the view of several possible applications in future electronics going from spintronics to quantum computing [1]. In this respect novel 2-dimensional materials (graphene, transition metal dichalcogenides, etc…) have attracted a considerable attention due to their outstanding electrons properties (Dirac Cone, outstanding mobility, etc...), although their use as building block for future electronics requires a modification of their band structure. One efficient way to achieve this goal consists in the use of interface effects. For example, the Dirac Cone spin degeneracy can be lifted by Rashba effect via the interface between graphene and high spin-orbit coupled materials [2]. It is expected that the coexistence of spin-orbit and exchange interaction in 2-D materials will open the access to novel quantum phases such as topological quantum spin Hall effect [3]. Such a situation has been little explored so far due to difficulties of sample preparation. In this project we propose to address the study of the electronic properties of such systems, where exchange and spin-orbit interactions are induced in the 2-D material by interface effects. The project will be carried on in collaboration with Prof. Yuriy Dedkov and Prof. Elena Voloshina at the Shanghai University (web page: https://shu2d.com).

[1] T.D. Ladd *et al.,* Nature, **464**, 45 (2010).
[2] I. I. Klimovskikh *et al.,* Phys. Rev. B **92**, 165402 (2015).
[3] Z. Qiao *et al.,* Phys. Rev. Lett. **112**, 116404 (2014).

Required background of the student: The successful applicant should have a strong background in solid-state physics and quantum mechanics. Knowledge of surface science and ultra-high vacuum techniques is welcomed.

A list of 5(max.) representative publications of the group: (Related to the research topic)
1) S. Vlaic *et al.,*. J. of Phys. Chem. Lett. **9**, 2523 (2018).
2) S. Vlaic *et al.*, Phys. Rev. Mat. **1**, 053406 (2017).
3) S Vlaic *et al.,* Appl. Phys. Lett. **104**, 101602 (2014).
4) Y. Dedkov and E. Voloshina, J. Phys.: Condens. Matter. **27**, 303002 (2015), Topical Review.
5) Y. Dedkov, E. Voloshina, *et al.,* Phys. Status Solidi B **252**, 451 (2015), Feature Article.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Physics, Hydrodynamics, Complex fluids, Microfluidics

ParisTech School: ESPCI ParisTech

Title: Fluid-structure interaction in microfluidic flows

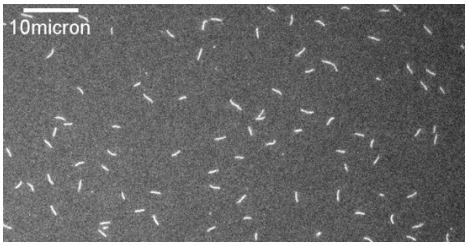
Advisor(s):

Anke Lindner (anke.lindner@espci.fr) and Olivia du Roure (olivia.duroure@espci.fr)

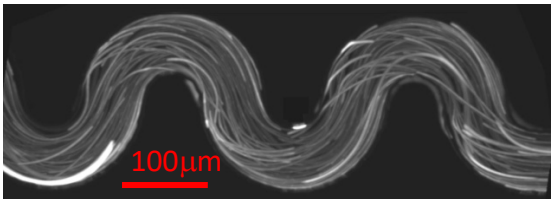
Websites: http://www.pmmh.espci.fr/~lindner/ and https://blog.espci.fr/oliviaduroure/

Short description of possible research topics for a PhD:

Complex fluids are ubiquitous in nature and industrial applications. In biology, saliva or blood are well-known examples of such fluids. Their non-Newtonian character is due to microscopic objects suspended in simple fluids. Under flow these objects are oriented, rearranged or deformed leading to a macroscopic response of the material. Precisely measuring this macroscopic response is not always possible using classical rheometers due to their limited resolution. Microfluidic rheometers using specific geometries can circumvent these limitations.



Model suspension of actin filaments (Image Yanan Liu, PMMH-ESPCI)



A novel microrheometer to acces normal stress differences (Josephine Zilz, PMMH-ESPCI).

Here we propose to build upon the knowledge gained in our group over the last years to study a model biofluid made of actin filaments in different microfluidic rheometers as for example the serpentine channel shown on the figure above.
Direct observations of the microscopic dynamics of the actin filaments under flow will reveal the nature of the fluid-structure interactions determining the filament deformation and transport. These microscopic interactions will be linked to the macroscopic suspension properties to establish a direct link.
The fundamental understanding gained in the PhD project will lead to a better understanding of the properties of real biofluids as well as the design of suspensions of specific properties, that could for example be used as replacement fluids for blood plasma.

Required background of the student: Physics, if possible Hydrodynamics, Complex fluids or Soft Matter

2-3 representative publications of the group:

1. Li et al (2018) *Morphological transitions of elastic filaments in shear flow.* PNAS 115 (38) 9438.
2. A. Lindner, *Flow of complex suspensions*, Phys. Fluids 26 101307 (2014)
3. A. Lindner and P. E. Arratia, *Special Topic: Invited Articles on Microfluidic Rheology,* Biomicrofluidics 10 (4), 2016

Research Topic for the ParisTech/CSC PhD Program

Field : Physics, Optics

Subfield: Applied Physics

Title: Smart Infrared Incandescent Sources

ParisTech School: Institut d'Optique Graduate School

Advisor Name: Jean-Jacques GREFFET
Advisor Email: jean-jacques.greffet@institutoptique.fr
(Lab, website): Laboratoire Charles Fabry,

Short description of possible research topics for a PhD:
Incandescent sources are made of materials at temperatures above 1000 K. Thermal radiation is usually assumed to be spatially incoherent (quasi isotropic) and temporally incoherent (broad emission spectrum). Furthermore, these sources cannot be modulated in intensity above 10-100 Hz due to thermal inertia.

However, no fundamental physics law forbids an incandescent source to be directional, monochromatic, polarized and be modulated at frequencies as large as 50 MHz. By revisiting the physics of thermal radiation at the nanoscale, our team has demonstrated spatially coherent sources [1], and introduced the concept of thermal source with high modulation rate [2]. In this project, we aim at designing and fabricating mid infrared sources operating in the 3-13 µm range which are directional, can emit polarized radiation and can be modulated at frequencies higher than 50 MHz. We will use absorbing materials coupled to nanoantennas [3]. The design is based on the emission theory reported in ref. [4].

Required background of the student:
We are seeking a highly motivated student with a master in Physics. The physics involved in the topic includes optics, nanophotonics, statistical physics.
The student will do numerical modelling of the electromagnetic fields in a nanostructure, nanofabrication in a clean room of the emitters and the nanoantennas, measurement of the emitted radiation using infrared Fourier transform spectrometers (FTIR).

List of 5(max.) representative publications of the group:

1. Coherent emission of light by thermal sources, J.J. Greffet, R. Carminati, K. Joulain, J.P. Mulet, S. Mainguy and Y Chen, Nature **416** p 61 (2002)
2. Controlled incandescence, Jean-Jacques Greffet, Nature **478**, p 191 (2011)
3. Enhancing thermal radiation with nanoantennas to create infrared sources with high modulation rates, E. Sakat, L. Wojszvzyk, J.P. Hugonin, M. Besbes, C. Sauvan, J.J. Greffet, Optica **5**, 175 (2018).
4. Light emission by nonequilibrium bodies: local Kirchhoff law, J.J. Greffet, P. Bouchon, G. Brucoli, F. Marquier, Phys.Rev.X **8**, 021008 (2018).

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Physics, Optics

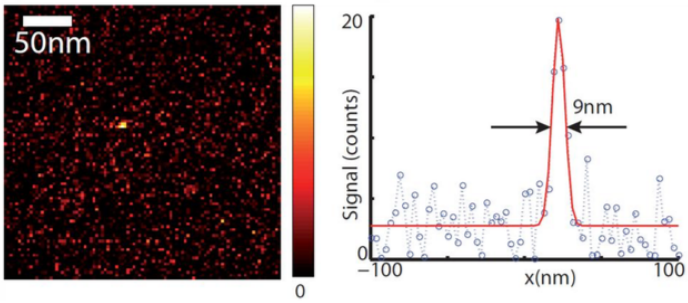
Subfield: Quantum optics

Title: Coherent dipole-dipole coupling of organic molecules at cryogenic temperatures.

ParisTech School: Institut d'Optique Graduate School (LP2N, UMR 5298)
Advisor(s) Name: Brahim Lounis/ Trebbia Jean-Baptiste
Advisor(s) Email: jean-baptiste.trebbia@institutoptique.fr
(Lab, website) : https://sites.google.com/site/bordeauxnanophotonicsgroup/home

Short description of possible research topics for a PhD:

The controlled, coherent manipulation of quantum systems is an important challenge in modern science, with significant applications in quantum technologies. Solid-state quantum emitters such as single molecules, quantum dots and defect centers in diamond are promising candidates for the realization of quantum bits and quantum networks. Because coupling mechanisms such as dipole–dipole or tunneling occur on a nanometer scale, it is crucial to develop experimental schemes that optically resolve quantum emitters at this scale and allow the manipulation of their degree of entanglement. Recently, we introduced a simple super-resolution optical nanoscopy method operating at cryogenic temperatures and achieved a sub 10-nm far-field optical resolution. We propose to use this technique to reveal the rich space-frequency signatures of coherent coupled quantum emitters and manipulate on demand their degree of entanglement.



The formation of collective quantum states from coupled optical emitters being a general phenomenon, these experimental schemes can also be useful for the study of many other systems including light harvesting complexes polymer conjugates, quantum dots molecules and hybrid systems.

Required background of the student:

Quantum mechanics, optics, light matter interaction.
The candidate's thesis will be mainly experimental. He/she will also develop the theoretical simulations necessary for the results interpretation. He/she will acquire a strong background in laser spectroscopy, single photon detection, quantum physics...

A list of 5(max.) representative publications of the group:

[1]-M. Khoshnegar, *et al.*, **A solid state source of photon triplets based on quantum dot molecules,** Nature communications 8 (2017) 15716.
[2]-Ivan S. Veshchunov *et al.,* **Optical Manipulation of Single Flux Quanta,** Nature communications 7 (2016) 12801.
[3]-Bin Yang, *et al.*, **Optical Nanoscopy with Excited State Saturation at Liquid Helium Temperatures**, Nature Photonics, 9 (2015) 658-662.
[4]-J.-B. Trebbia *et al.*, **Indistinguishable near-infrared single photons from an individual organic molecule**, Phys. Rev. A., 82 (2010) 063803.

Research Topic for the ParisTech/CSC PhD Program

Field : Physics, Optics

Subfield: Quantum technologies

Title: Controlling spontaneous emission of quantum emitters

ParisTech School: Institut d'Optique Graduate School

Advisor Name: Jean-Jacques GREFFET
Coadvisor Name: Benjamin VEST
Advisor Email: jean-jacques.greffet@institutoptique.fr
Lab: Laboratoire Charles Fabry,

Short description of possible research topics for a PhD:

Recent progress in the field of nanophotonics allow controlling spontaneous emission of light by atoms or molecules using subwavelength systems such as cavities or antennas. This line of research allows designing systems to generate single photon sources that will be used for implementing quantum technologies and study fundamental aspects of light matter interaction at the nanoscale. We have recently explored the possibility to perform quantum optics using surface waves propagating along metal-vacuum interfaces called surface plasmons [1,2]. We have also explored the possibility to tune light emission by quantum dots using plasmonic antennas [3,4].

The project of this PhD is to develop a new line of research exploring light emission by defects in h-BN. h-BN is a 2D material analogous to graphene. In these systems, it has been discovered recently that vacancies can produce localized defects which can be used as single photon sources with remarkable properties. In particular, these systems are extremely bright and can be used at ambiant temperature, two key advantages as compared to NV centers in diamond. However, little is known about these defects. We will explore how it is possible to control the polarization, lifetime and emission direction of these emitters using nanostructures playing the role of nanoantennas.

Required background of the student:
We are seeking a highly motivated student with a master in Physics. The physics involved in the topic includes optics, nanophotonics and quantum optics.
The student will do numerical modelling of the electromagnetic fields in a nanostructure, nanofabrication in a clean room of the emitters and the nanoantennas, single photon measurements (spectroscopy, correlation measurements).

List of 5(max.) representative publications of the group:

1. Single-plasmon interferences, MC Dheur, E. Devaux, T.W. Ebbesen, A. Baron, JC Rodier, JP Hugonin, P. Lalanne, JJ Greffet, G. Messin, F. Marquier, Science Advances **2**, e1501574 (2016).
2. Anti-coalescence of bosons on a lossy beam splitter, B. Vest, M.C Dheur, E. Devaux, A. Baron, E. Rousseau, J.P. Hugonin, J.J. Greffet, G. Messin, F. Marquier, Science **356**, 1373 (2017)
3. Non-blinking quantum dot with a plasmonic nanoshell resonator
Botao Ji et al. Nature Nanotechnology **10**, p 170 (2015)
4. Controlling Spontaneous Emission with Plasmonic Optical Patch Antennas, C. Belacel et al. Nanoletters **13**, p 1516 (2013) **DOI:** 10.1021/nl3046602

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below): Physics, Optics***

Subfield: Quantum physics

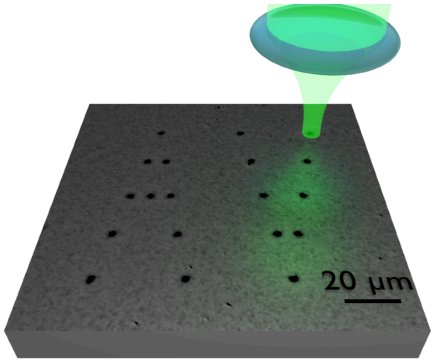
Title: Interaction between a magnetic flux quantum and a quantum nano- emitter

ParisTech School: LP2N (Univ. Bordeaux, IOGS & CNRS)

Advisor(s) Name: B. Lounis/P. Tamarat
Advisor(s) Email: brahim.lounis@u-bordeaux.fr
(Lab, website): https://sites.google.com/site/bordeauxnanophotonicsgroup/home

Short description of possible research topics for a PhD:

Abrikosov vortices are the most compact magnetic objects, with a size of a few tens to a few hundred nanometers. They are flux tubes which penetrate type II superconductors (such as Niobium), carry a quantum of flux h/2e and are surrounded by super-currents. Recently, our group demonstrated the ability to manipulate single flux quanta with a laser beam, as simply as with optical tweezers.



The main goal of the doctoral project is to explore the magnetic interaction between a laser driven quantum of flux and a single spin present in a quantum nano-emitter such as a single color center in diamond. The spin state read-out will be performed with optically detected magnetic resonance. Combined with 3D super-resolution methods of single quantum emitters developed in our group, this study will provide the opportunity to precisely map the distribution of magnetic field around a vortex.

Required background of the student: (Which should be the main field of study of the applicant before applying): quantum physics, optics, solid state physics, lab training.

A list of 5(max.) representative publications of the group: (Related to the research topic)

« Optical Manipulation of Single Flux Quanta», I. Veshchunov et al. Nature Comm. 7 (2016) 12801.
« Direct Evidence of the Flexomagnetoelectric Effect Revealed by Single- Molecule Spectroscopy", I. Veshchunov et al., Phys. Rev. Lett. 115 (2015) 027601.
« Optical nanoscopy with excited state saturation at liquid helium temperatures" B. Yang et al., Nature Photonics 9 (2015) 658–662.

Research Topic for the ParisTech/CSC PhD Program

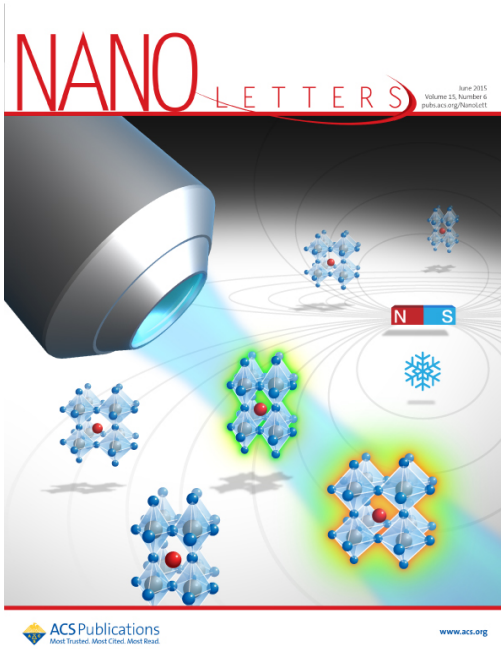
***Field (cf. List of fields below): Physics, Optics**
Subfield: Nanophotonics

Title: Exploring the fundamental optical properties of perovskite single nanocrystals

ParisTech School: Institut d'optique Graduate School (LP2N, UMR 5298)
Advisor(s) Name: P. Tamarat/B. Lounis
Advisor(s) Email: philippe.tamarat@u-bordeaux.fr
(Lab, website): https://sites.google.com/site/bordeauxnanophotonicsgroup/home

Short description of possible research topics for a PhD:

Recent advances in the colloidal synthesis of strongly emitting lead halide perovskite nanocrystals open up new possibilities for the fabrication of tunable light sources based on the composition and quantum-size-effect tuning, such as light-emitting diodes and lasers, and for the exploration of their potential use as quantum light sources.



The goal of this doctoral work is to explore the properties of the emitting states in perovskite nanocrystals, using magneto-optical spectroscopy and time-resolved spectroscopy of the materials at the single particle level. In particular, we will aim at revealing the spectral fingerprint of the band-edge exciton, which yields precious information on the crystallographic structure of the nanocrystals (that can hardly be obtained with X-ray diffraction methods). The crystal structure is indeed one of the many physical properties that can differ between nanometer-sized and bulk crystalline materials. It also has a major impact on the optical properties of inorganic perovskites and thus on their suitability for photovoltaic or light emitting applications. This study of the fine structure should also shed light on the strength of the Rashba effect in these materials.

We will also explore the exciton-phonon coupling in these nanocrystals, since phonon scattering sets a fundamental intrinsic limit to the charge carrier mobility. This coupling will be extracted from the evolution of the photoluminescence spectra of single nanocrystals with temperature. It will be of prime importance to guide the development of next-generation devices for photovoltaics and for quantum technologies.

Required background of the student: quantum physics, optics, solid state physics, lab training.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1. « Neutral and charged exciton fine structure in single lead halide perovskite nanocrystals revealed by magneto-optical spectroscopy », M. Fu et al., Nanoletters, 17 (2017) 2895-2901.
2. "Unravelling exciton-phonon coupling in individual FAPbI3 nanocrystals emitting near-infrared single photons", M. Fu et al., Nature Communications, 9, 3318 (2018).

Research Topic for the ParisTech/CSC PhD Program

Subfield: Chemical Engineering

ParisTech School: Mines ParisTech

Title:**Thermodynamic aspects of transport of CO2: phase equilibrium and transport** properties

Advisor(s): Christophe Coquelet, Christophe.Coquelet@mines-paristech.fr, http://www.ctp.mines-paristech.fr/About-us/

Short description of possible research topics for a PhD:
The context of the study is twofold: In the CCS context, CO_2 is generally capture from power plant and must be transport to the location of storage or valorization. The CO_2rich stream contains a lot of impurities like CO, NOx, Sox, Ar, N_2, etc.. These impurities have a non-negligible impact on the phase diagram and modify the classical condition of transportation (modification of densities, bubble and dew pressure, etc..).
Also, many new natural gas reservoirs contain important quantities of acid gases. These acid gases are mainly composed of CO_2, H_2S and other sulphur components like methyl-mercaptans. After acid gases absorption using chemical absorption process, the acid gases removed from natural gas contains also some impurities like aliphatic hydrocarbons and aromatics. Acid gas injection involves compressing the blend of acid gas and hydrocarbons commonly produced during sour gas sweetening.
Acid-gas injection operations constitute a commercial-scale analogue for CO_2 geological sequestration in sedimentary basins.

Scientific objectives

The first one concerns the complete determination of phase diagrams including acid gases, NOx, SO_2, and other hydrocarbons. This point is very important for the determination of PT envelop essential for the design of compressor. Density measurementsare also expected. The second objective is the development of thermodynamic models allowing the treatment of the measured data (literature or new one) and prediction of phase diagrams. The last objective concerns the determination of transport properties (viscosities) and heat capacities in order to test the developed models.

Required background of the student:
Thermodynamics of fluids, experimental work, oil and gas engineering, chemical engineering

A list of 5(max.) representative publications of the group:
-M. Nazeri, A. Chapoy, A. Valtz, C. Coquelet, B. Tohidi, 2017, Fluid Phase Equilibria, 454, 64-77
-C Coquelet, P Stringari, M Hajiw, A Gonzalez, L Pereira, M Nazeri, R.Burgass, A. Chapoy, 2017, Energy Procedia 114, 6844-6859
-A. Gonzalez Perez, A.Valtz, C.Coquelet, P.Paricaud and A.Chapoy, 2016, Fluid Phase Equilibria, 427, 371–383
-M. Hajiw, A. Chapoy, C. Coquelet, 2015, Can. J. Chem. Eng. 93 (2), 432-442
-A. Chapoy, C. Coquelet, H. Liu, A. Valtz, B. Tohidi, 2013, Fluid Phase Equilibria, 356, 223-228.

Research Topic for the ParisTech/CSC PhD Program

Field : Environment Science and Technology, Sustainable Development, Geosciences

Subfield: Geomechanics

Title: Numerical modeling of induced seismicity due to fluid-injection in Geo-Energy systems

ParisTech School: Mines ParisTech – PSL University

Advisor(s) Name: Frédéric Pellet
Advisor(s) Email: frederic.pellet@mines-paristech.fr
(Lab, website): Centre de Géosciences

Short description of possible research topics for a PhD:

Geoenergy is one of the most promising techniques to exploit renewable energy resources from the Earth in order to limit emissions of green house gas. It can be considered as a base load energy, nearly CO2 free. Producing electricity from geoenergy requires producing fluids at temperatures larger than 150 °C and at significant mass rates. Such targets can be found either in deep basins, in faulted basements or in volcanic areas.

The economic factors also involve a long operating duration. Thus deep geothermal exploitations are associated to long term fluid circulation and pressure perturbations at great depth, in fractured and faulted zones with possible connections to the basement and are likely associated to a risk of triggering earthquakes and inducing seismicity.

To reduce induced seismicity occurrences, comprehensive Thermo-Hydro-Mechanical numerical simulations formulated with the dynamics equations (equation of motions) are needed. This approach must be validated with field data using inverse analysis techniques. Moreover, because uncertainties affect many features of geothermal reservoirs (fractures density, fault extension and orientation) a stochastics approach is also required.

Required background of the student: Materials Science, Mechanics or Civil Engineering

A list of 5(max.) representative publications of the group:

Ngo, D.T., Pellet, F.L. (2018) Numerical modeling of thermally-induced fractures in a large rock salt mass, Journal of Rock Mechanics and Geotechnical Engineering, vol 10, 5 : 844 - 855 (doi.org/10.1016/j.jrmge.2018.04.008)

Pellet F.L. (2017), Rock mechanics is meeting the challenge of geo-energies, Procedia Engineering, Symposium of the International Society for Rock mechanics, Eurock 2017, vol 191: 1104 – 1107 (doi.org/10.1016/j.proeng.2017.05.284)

Ngo D.T., Pellet F.L., Bruel D. (2017), Numerical modeling of rock fracturing in geothermal systems, Proc. 6th International Conference on Coupled THMC Processes in Geosystems, GeoProc 2017, Paris, France.

Pellet, F.L., Selvadurai, A.P.S. (2016), Rock damage mechanics, Chapter 3, In Rock Mechanics and Engineering: Vol. 1 Principles, ISRM Book series, CRC Press / Balkema – Taylor & Francis Group, Leiden, pp 65-107.

Pellet, F.L. (2013), Thermal and mechanical damage to rocks under different loading conditions and consequences for behavior of underground openings Scandinavian Rock mechanics meeting, Bergmekanikdagen 2013 , Ed. BeFo, Stockholm, pp 1-13.

Research Topic for the ParisTech/CSC PhD Program

Field : Urban planning, Transport – Civil engineering

Subfield: Geotechnical engineering

Title: **Decision Aid Tools for tunnel excavation in complex geotechnical conditions**

ParisTech School: Mines ParisTech- PSL University

Advisor(s) Name: Frédéric Pellet
Advisor(s) Email: frederic.pellet@mines-paristech.fr
(Lab, website): Centre de Géosciences

Short description of possible research topics for a PhD:

The excavation of deep tunnels in complex geotechnical conditions (squeezing rock, rock prone to burst, major fault crossings) often leads to rock instabilities which may cause delays in construction and sometimes casualties. To prevent such hazard, comprehensive risk assessment approaches need to be cautiously performed. For this purpose deterministic numerical modeling of the tunnel construction process associated with stochastic analyses provides a valuable tool. Moreover, it helps the constructor to overcome unexpected events with flexible and appropriate countermeasures.

In this research program, it is planned to develop numerical simulations with the Finite Element Method, accounting for the complexity of geomaterials behavior (hydro-mechanical couplings, etc) and realistic boundaries and initial conditions. Cases of deep tunnels realized through the Alps will be studied. Simulations will be coupled with probabilistic analysis software to account for uncertainties and representativeness bias (scale effect). In the final stage, the candidate will propose a Decision Aid Tools to run the methodology he/she developed to account for complex geotechnical conditions in tunneling.

Required background of the student: Civil Engineering, Numerical Modelling

A list of 5(max.) representative publications of the group: (Related to the research topic)

- Pellet F.L. (2017) Underground Urban Development and Geo-Environmental Issues, Editorial, Environmental Geotechnics, vol 4, 1: 1-2 (doi.org/10.1680/jenge.2017.4.1.1)
- Pellet, F.L. (2016), Rock creep mechanics, Chapter 24, In Rock Mechanics and Engineering: Vol. 1 Principles, ISRM Book series, CRC Press / Balkema – Taylor & Francis Group, Leiden, pp 745-770.
- Pellet, F. L. (2009) Contact between a tunnel lining and a damage-susceptible viscoplastic medium, Computer Modeling in Engineering and Sciences, Tech Science Press, 52 (3): 279-296.
- Pellet, F.L., Roosefid, M., Deleruyelle, F., On the 3D numerical modelling of the time-dependent development of the Damage Zone around underground galleries during and after excavation, Tunnelling and Underground Space Technology, 2009, 24 (6): 665-674.
- Pellet, F.L, Viscoplasticity and rock damage in modelling the long-term behaviour of underground excavations, Chapitre 14, X Ciclo di Conferenze di Meccanica e Ingegneria delle Rocce - MIR, Patron Editore, Torino, Italie, 2004, pp 423 - 448.

Research Topic for the ParisTech/CSC PhD Program

1. ***Field (cf. List of fields below):***

   # Chemistry, Physical Chemistry and Chemical Engineering

   # Energy, Processes

Subfield: Applied Physics and Chemistry

Title: Study of carbon particles nucleation and growth in methane plasma cracking

ParisTech School: MINES ParisTech

Advisor(s) Name: Vandad ROHANI, Laurent FULCHERI,François CAUNEAU

Advisor(s) Email:
vandad-julien.rohani@mines-paristech.fr
laurent.fulcheri@mines-paristech.fr

(Lab, website):
PERSEE, Center for Processes, Renewable Energies and Energy Systems
http://www.persee.mines-paristech.fr

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

In the prospect of a large scale deployment of Renewable Energy for electricity production, plasma will definitively be a major option to get tunable high temperature enthalpy source without direct CO2 emission. In this frame, plasma cracking ofmethane for the simultaneous synthesis of hydrogen and high value-added carbon black is particularly interesting for both energy and materials industries.
The PhD work will consist in making a global model of carbon particles nucleation and growth from a gas phase in the methane plasma cracking. First, an exhaustive review of physicochemicalphenomena occurring in gas phase during the carbon particles formation process will be done, mainly based on the works in the field of combustion. Then, as a continuation of a modeling work already started in our group for few years (Maxime Gautier's PhD), the candidate will have the objective to improve the existing model based on a discretized Smoluchowski's approachby developing/implementing: (i) the reaction mechanisms taking place in the nucleation step, (ii) the physical phenomena allowing the growth of the carbon particles, particularly the transition from a coalescent coagulation (giving the elementary particles) to a non-coalescent one (giving the agglomerates). This last step is one of the most difficult steps to model because of the influence of multiple driving factors. At the end, the model will be able to give the distribution of particles at the outlet of a typical plasma cracking reactor from the process parameters.

Required background of the student: (Which should be the main field of study of the applicant before applying)

The candidate must have a strong background in physics and chemistry and must be familiar with numerical modeling, particularly by Finite-Volume technic. Knowledge of following softwareswill be greatly appreciated: Fluent, Chemkin, Matlab. From a more global point view, the candidate should have a passion for physical and chemical sciences.

A list of 5(max.) representative publications of the group: (Related to the research topic)

Gautier M., Rohani V., Fulcheri L., Direct decarbonization of methane by thermal plasma for co-production of carbon black and hydrogen, *Int. Journal of HydrogenEnergy*, 42 (2017) 28140-28156

Gautier M., Trelles J. P., Rohani V., Fulcheri L., Influence of Temperature and Pressure on Carbon Black Size Distribution during Allothermal Cracking of Methane, *Aerosol Science and Technology*, 50, 1 (2016)

Gautier Maxime, PhD thesis: Etude de la formation de nanoparticules de carbone au cours de la décomposition thermique d'hydrocarbures : application au craquage thermique du méthane, Mines ParisTech, 2016

Research Topic for the ParisTech/CSC PhD Program

Fields: 3. Economics, Management and Social Sciences
5. Environment Science and Technology, Sustainable Development, Geosciences
9. Mathematics and their applications

Subfield: Long-term modelling, Energy system, Carbon market, Optimization

Title:The role of Carbon Market in the Chinese Energy Transition: long-term optimization of the Chinese energy system

ParisTech School: MINES ParisTech, Centre for Applied Mathematics

Advisors: Nadia Maïzi ;nadia.maizi@mines-paristech.fr
Sandrine Selosse ; sandrine.selosse@mines-paristech.fr

(Lab, website):*Centre for Applied Mathematics, MINES ParisTech, http://www.cma.mines-paristech.fr/en*

Short description of possible research topics for a PhD: The Centre for Applied Mathematics (CMA) is a research Centre at MINES ParisTech reputed for its expertise on optimization of the energy system and on prospective modelling for energy-climate issues. The Centre develops methodologies to build multi-scale (spatial and temporal) models to address the challenges of evolutions in the energy system. It develops models using the TIMES model generator, which is widely employed in the international community. The general framework of this research is the prospective assessment of the Chinese energy system challenges in the long-term 2050-2100. This question will here be considered from the angle of the decisions between different technological options leading to a reduction in greenhouse gases emissions and the ambitious carbon market that can deep the Chinese action on climate change. In other words, how China can pursue its modernization, with a huge industrialization and urbanization project started since thirty years with high growth rates, undertaking a low carbon pathway in the future? And how optimizing these pathways between the new Carbon market and mitigated technologies. This analysis should be done through the development of a Chinese TIMES optimization model.

Required background of the student: The candidate (s) must demonstrate a strong interest in this field of research and obtained a Master level (or equivalent) in optimization, applied mathematics or mathematical economics.

A list of representative publications of the group:

S. Kang, S. Selosse, N. Maïzi. Contribution of global GHG reduction pledges to bioenergy expansion. *Biomass and Bioenergy*, Elsevier, 2018, 111, pp.142-153.

S. Postic, S. Selosse, N. Maïzi. Energy contribution to Latin American INDCs: Analyzing sub-regional trends with a TIMES model. *Energy Policy*, Elsevier, 2017, 101, pp.170-184.

S. Kang, S. Selosse, N. Maïzi, Strategy of bioenergy development in the largest energy consumersof Asia (China, India, Japan and South Korea),*Energy Strategy Reviews*, 2015, 8, pp.56-65.

N. Maïzi (Co-Author), *A Global Renewable Energy Roadmap: Comparing Energy Systems Models with IRENA's REmap 2030 Project*, in Informing Energy and Climate Policies Using Energy Systems Models, Lecture Notes in Energy, Volume 30, 2015, Springer, pp. 43-67

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Information and Communication Sciences and Technologies

Subfield: Machine-Learning

Title: Deep Reinforcement Learning (DRL) for teaching behaviors to collaborative robots

ParisTech School: MINES ParisTech

Advisor(s) Name: Pr Fabien MOUTARDE
Advisor(s) Email: Fabien.Moutarde@mines-paristech.fr
(Lab, website): Center for Robotics, http://caor-mines-paristech.fr/en/home/

Short description of possible research topics for a PhD: *(10-15 lines in English + optional figure)*
Since 2012, the breakthrough of Deep Convolutional Networks (convNets) has brought tremendous progress in Image Understanding. Furthermore in 2017, the AlphaGO algorithm obtained by Reinforcement Learning (RL) succeeded in beating human go player world champions. This has fostered huge interest in Deep Reinforcement Learning (DRL) as an extremely promising paradigm for the design of behavior and planning of robots and autonomous vehicles.
The center for Robotics of MINES ParisTech already conducts research on DRL for end-to-end vehicle driving, and on Human actions/gestures understanding for Collaborative Robots in the factory of the future. *The proposed research topic is to focus on Deep Reinforcement Learning (DRL) for teaching behaviors to collaborative robots*. One of the current issues regarding RL is the usually very slow training, requiring huge number of trials and errors. For collaborative robots, another approach for teaching behavior is "learning by demonstration". A promising research direction is therefore to leverage the latter within DRL, in order to drastically accelerate robot behavior learning.

Required background of the student: Machine-Learning, Deep-Learning, Robotics

A list of 5(max.) representative publications of the group: (Related to the research topic)

"Coupled Longitudinal and Lateral Control of a Vehicle Using Deep Learning", Guillaume Devineau, Philip Polack, Florent Altché and Fabien Moutarde, proc. of 21st IEEE International Conference on Intelligent Transportation Systems (ITSC'2018), Maui, Hawaii, USA, November 4-7, 2018.

"End to End Vehicle Lateral Control Using a Single Fisheye Camera", Marin Toromanoff, Emilie Wirbel, Frédéric Wilhelm, Camilo Vejarano, Xavier Perrotton et Fabien Moutarde, 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2018), Madrid (Spain), 1-5 oct. 2018.

"Multi-users online recognition of technical gestures for natural Human-Robot Collaboration in manufacturing", Eva Coupeté, Fabien Moutarde and Sotiris Manitsaris, *Autonomous Robots* journal, https://doi.org/10.1007/s10514-018-9704-y, 2018.

"Deep Learning for Hand Gesture Recognition on Skeletal Data", Guillaume Devineau, Wang Xi, Fabien Moutarde and Jie Yang, proc. 13th IEEE Conference on Automatic Face and Gesture Recognition (FG'2018), Xi'An (China), 15-19 May 2018.

"A Distributed MPC Framework for Road-Following Formation Control of Car-like Vehicles", Xiangjun Qian, Florent Altche, Arnaud de La Fortelle and Fabien Moutarde, proc. of 14th International Conference on Control, Automation, Robotics and Vision (ICARCV'2016), Phuket (Thailand), November 13–15, 2016.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Subfield: Electrical engineering, applied mathematics, smart grid

ParisTech School: MINES-ParistTech

Title: Big data based forecasts for the electric power system

Advisor(s): Andrea Michiorri, andrea.michiorri@mines-paristech.fr, Georges Kariniotakis, georges.kariniotakis@mines-paristech.fr

Short description of possible research topics for a PhD:
Context: This research is based on the following considerations: 1) Forecasts for electricity demand, production from renewables or electricity prices are used as decision making support by power system's actors. 2) These parameters are in part correlated and can be forecast with the help of the same data, for example: weather forecasts, production and consumption measurements, satellite images, traffic information, news; it is then possible to exploit these correlations in order to increase the accuracy of the forecasts. 3) Increasing the size of data sources and the complexity of the models results in an increase of the cost but also in the necessity of identifying and developing adequate numerical methods in order to face problems such as the overfitting.
Objectives: The scientific objectives of this research are: A) to develop forecast models for the state of the electric power system (production and consumption in all nodes or regions and prices in the different markets). Particular attention will be given to the forecast of extreme values and of rare events. B) To study the resilience of the models developed respect to the overfitting and to the presence of missing data or outliers. C) To compare the performance of the models developed with the state of the art and to evaluate the relative importance of the datasets used.
Methodology: The research will be organized according to the following plan: i) A preparation phase characterized by a bibliographic research, the appropriation by the student of the necessary tools and the research of the available databases. The data used will be open data (eg: data made public by regulated utilities), data available for research (eg: weather forecast and measurements) and data provided by partners of MINES-ParisTech within the framework of bilateral agreements. ii) A second phase regarding the development of the forecast models (point A). iii) A third phase for the evaluation of the models.

Required background of the student: Applied mathematics, informatics, machine learning

A list of 5 (max.) representative publications of the group:

1. Andrea Michiorri, Huu-Minh Nguyen, et al., "Forecasting for dynamic line rating", Renewable and Sustainable Energy Reviews, 2015/12/31, Vol 52, pp 1713-1730
2. Andrea Michiorri, Philip C Taylor, "Forecasting real-time ratings for electricity distribution networks using weather forecast data", Electricity Distribution-Part 1, 2009. CIRED 2009. 20th International Conference and Exhibition on
3. Arthur Bossavy, Robin Girard, Andrea Michiorri, Georges Kariniotakis, "The impact of available data history on the performance of photovoltaic generation

forecasting models", Electricity Distribution (CIRED 2013), 22nd International Conference and Exhibition on
4. Romain Dupin, Andrea Michiorri, Georges Kariniotakis, "Dynamic Line Rating Forecasting and Evaluation", EWEA Technology Workshop, Wind Power Forecasting 2015

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Subfield: Electrical engineering, applied mathematics, smart grid

ParisTech School: MINES-ParistTech

Title: Dynamic Line Rating: risk and impact on investment planning

Advisor(s): Andrea Michiorri, andrea.michiorri@mines-paristech.fr, Georges Kariniotakis, georges.kariniotakis@mines-paristech.fr

Short description of possible research topics for a PhD:
Context: Dynamic line rating (DLR) is a technology able to modify in real time the current carrying capacity of power system components such as overhead lines, power transformers and electric cables. It has the potential to reduce network charges, but several challenges needs to be addressed before its implementation.
Objectives: This thesis is focused on two points: 1) to develop a methodology to safely determine DLR to be applied. 2) To study the impact of the application of DLR on investment planning, both for the network (network reinforcements) and for network users (reduced connection cost).
Methodology: The focus will be kept on overhead lines, but transformers and electric cables can be investigated as well. For point 1) several approaches will be considered and/or combined: a) the use of historical data, weather reanalysis and climate projections to create a DLR climatology, b) the use of daily probabilistic forecasts, c) a risk-based approach. For point 2) simulations will be carried out on well-defined use cases comparing the benefits and drawbacks of the application of DLR. Examples are: a) retarding network reinforcements following load or renewable production increase, b) reducing renewable's connection cost.;

Required background of the student: Electrical engineering (power systems)

A list of 5 (max.) representative publications of the group:

1. Andrea Michiorri, Huu-Minh Nguyen, et al., "Forecasting for dynamic line rating", Renewable and Sustainable Energy Reviews, 2015/12/31, Vol 52, pp 1713-1730
2. Andrea Michiorri, Philip C Taylor, "Forecasting real-time ratings for electricity distribution networks using weather forecast data", Electricity Distribution-Part 1, 2009. CIRED 2009. 20th International Conference and Exhibition on
3. Romain Dupin, Andrea Michiorri, Georges Kariniotakis, "Dynamic Line Rating Forecasting and Evaluation", EWEA Technology Workshop, Wind Power Forecasting 2015

Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below):** **4.Energy, Processes

Subfield: Energy Efficiency

Title: Default detection for district heating networks using machine learning

ParisTech School: MINES ParisTech

Advisors : Cong-Toan TRAN (cong-toan.tran@mines-paristech.fr)
Assaad ZOUGHAIB (assaad.zoughaib@mines-paristech.fr)

(Lab, website): http://www.ces.mines-paristech.fr/Accueil/

Short description of possible research topics for a PhD:
In the district level, a thermal network is one the most efficient technologies to fulfill the energy requirements (space heating/cooling or domestic hot water). Considering the size of the network (generally composed of thousands houses), default in the network is a recurrent problem and detection of default is a challenge. The most common methods for detection of default aim to model the whole network. However, the model, including production systems, pipelines and substations, needs to be calibrated and this work could be a long and meticulous task. A promising solution is to use machine learning techniques, because we need only to develop one model and the training phase can be performed automatically for any substations or equipments. In this context, the thesis aims to identify the most appropriate machine learning architectures for default detection problems. Different architectures, especially the ones suitable to time series data such as recurrent neural network (RNN), will be tested and compared. It will be necessary to develop a virtual environment in which the state is defined via a physical model. That will allow to test the performance of the "detector" when running online.

Required background of the student: Thermodynamics, Heat transfer, Optimization, Process modeling, Programming

A list of 5(max.) representative publications of the group: (Related to the research topic) [1–5]

1. Apostolou, M., Tran, C.-T., Ghazouani, S., Le Bourdiec, S. & Zoughaib, A. A Multi-Period MINLP Model for district heating networks design considering production systems architecture optimization. in *ECOS Conference* (2017).
2. Apostolou, M., Salame, S., Barrault, S. & Zoughaib, A. Heat Pumps Architecture Optimization For Enhanced Medium Temperature Geothermal Heat Use in District Heating. *Int. Compress. Eng. Refrig. Air Cond. High Perform. Build. Conf.* (2016).
3. Apostolou, M., Ghazouani, S., Le Bourdiec, S., Tran, C.-T. & Zoughaib, A. District heating network design considering fluctuations in the demand and thermal storage means. in *ECOS Conference* (2018).
4. Fable, A., Tran, C. T., Duplessis, B. & Stabat, P. Impact and detection of malfunction on district heating networks. in *10th International Conference on System Simulation in Buildings (will be presented in Dec. 2018)* (2018).
5. Fabre, A., Thomas, R., Duplessis, B., Tran, C.-T. & Stabat, P. Dynamic modeling for evaluation of triple-pipe configuration potential in geothermal district heating networks. *Energy Convers. Manag.* **173,** 461–469 (2018).

Research Topic for the ParisTech/CSC PhD Program

Subfield: Computer Science and Mathematics

ParisTech School: MINES ParisTech

Title: Efficiency, Scalability and Interactivity for Rewriting at Higher-Order

Advisor(s): Frédéric Blanqui, Olivier Hermant, Emilio Gallego-Ariás
olivier.hermant@mines-paristech.fr, http://cri.ensmp.fr/people/hermant/
frederic.blanqui@inria.fr, http://rewriting.gforge.inria.fr/
emilio.gallego_arias@mines-paristech.fr

Short description of possible research topics for a PhD:

Computer-assisted proof verification has become a crucial tool to assist the development of safe software and protocols. We are developing Dedukti, a universal proof checker that allows to combine and verify proofs from various systems in a novel and convenient way. Dedukti is based on a logical framework extended with rewriting techniques, called deduction modulo theory. Our research thus range from extending the implementation of Dedukti to theoretical work on the formalism underneath, in consequence we propose research topics in this entire range, depending on the interests of the candidate.

On the implementation side, we propose to use the library Bindlib, developed in France, to get better rewriting performances, and to extend Dedukti towards rewriting modulo associativity-commutativity. We also plan to develop an interface for Dedukti by using SerAPI, developed at MINES ParisTech, and adopting an approach similar to jsCoq. One last step towards usability of Dedukti will be to implement proof tactics, so as to build interactive proofs.

We also propose topics, that make a bridge between theory and practice. As Dedukti is a logical framework, it is essential to ensure strong properties the system. This is why we would like to develop a termination checker to Dedukti, based on the Computability Path Ordering (CPO), developed at Inria. Another direction, that we are currently investigating is the development of refinement types, that is both a theoretical challenge and that would allow to develop interactive proofs in practice by "guessing" the proof-term, instead of asking the user for it. Lastly, we also are investigating new ways of computing, called normalization by evaluation, which is for the moment a theoretical work, but could at the same time lead to speedups in the implementation.

For more details, please refer to the webpages of the advisors, also do not hesitate to get in touch with them.

Required background of the student:

The main required background is a Master level in Computer Science or Mathematics.

An advanced course on the foundations of computer science/mathematics such as functional programming, logic, type theory, category theory would be a plus.

Representative publications of the group: (Related to the research topic)

Ronan Saillard, *Type Checking in the lambda-Pi Calculus modulo, Theory and Practice*, [http://www.cri.ensmp.fr/people/saillard/Files/thesis.pdf]

Gaëtan Gilbert, and Olivier Hermant, *Normalization by Completeness with Heyting Algebras*, In Logic for Programming, Aritificial Intelligence, and Reasoning, LPAR 2015. [http://www.cri.ensmp.fr/classement/doc/A-614.pdf]

Frédéric Blanqui, Jean-Pierre Jouannaud and A. Rubio, *The Computability Path Ordering*, in Logical Methods in Computer Science 11(4:3):1-45, 2015 [http://rewriting.gforge.inria.fr/lmcs15-pdf.html]

A. Asperti, W. Ricciotti, C. Sacerdoti Coen and E. Tassi, *A bi-directional refinement algorithm for the calculus of (co)inductive constructions*, in Logical Methods in Computer Science 8:1-49, 2012 [http://dx.doi.org/10.2168/LMCS-8(1:18)2012]

E. J. Gallego Arias, B. Pin, and P. Jouvelot, *jsCoq: towards hybrid theorem proving interfaces,* In Proceedings of the 12th Workshop on User Interfaces for Theorem Provers, Electronic Proceedings in Theoretical Computer Science, 2016. [http://feever.fr/Papers/jscoq.pdf]

A. Assaf, G. Burel, R. Cauderlier, D. Delahaye, G. Dowek, C. Dubois, F. Gilbert, P. Halmagrand, O. Hermant, and R. Saillard. *Expressing Theories in the lambda-Pi-Calculus Modulo Theory and in the Dedukti System,* 2016. Draft. [http://lsv.fr/~dowek/Publi/expressing.pdf]

Scaling Up Polarized Deduction Modulo with Machine Learning

Research Topic for the ParisTech/CSC PhD Program

Subfield: Computer Science, Applied Mathematics

ParisTech School: MINES ParisTech

Title: Scaling Up Polarized Deduction modulo with Machine Learning

Advisor: Olivier Hermant, `http://cri.ensmp.fr/~hermant/`

Keywords: proofs, machine learning, rewriting, theorem provers, proof assistants, first-order logic, type systems, semantics

1 Formal Methods for Safer Software

Software industry produces the most complex objects ever seen. Managing program complexity is hard and frequently results misfunctionments (bugs) and vulnerabilities, whose origins are a misconception or a faulty implementation.

Formal methods help increase quality, especially of critical software (driveless cars, trains, and planes, embarked software). Several techniques exist, like model checking, abstract interpretation, static analysis, proof assistants and automated theorem proving. They have drawn more attention in the past decades, but still lack automation.

This proposal is at the crossroad of proof assistants, automated theorem proving and machine learning, it concerns both implementation, proof theory and learning over a large body of proofs. It aims at enhancing two tools with polarized rewriting: Dedukti (proof checker) and Zenon Modulo (automated theorem prover). Those tools are recent and already used in an industrial platform for safe-by-construction software [The12].

2 The Framework: Deduction Modulo Theory

The gist of Deduction Modulo Theory is to embed computation, via *rewrite rules*, within proof systems. This speeds up provers by avoiding the need for axioms and emphasizing the computational and deterministic nature of parts of proofs. It also offers a versatile and efficient way to express proof assistants in a shallow way, when combine with a type system like LF.

Currently, Deduction Modulo Theory has been successfully implemented in a resolution-based prover [Bur11] and in a tableau-based prover [BDD$^+$15] and has given very promising results [BBC$^+$17, Ji15].

Polarized Deduction Modulo Theory [Dow10] is an improvement over Deduction Modulo Theory [DHK03], that allows rewrite rules to be selectively applied to the hypothesis or to conclusion side of proofs. One of the avantages of this approach is the possibility to express asymetric axioms. Moreover, the generated rewrite system lends itself well to Skolemization, in particular in classical logic, which would further speeds up proof-seach. This is the direction we want to push forward.

3 Research Directions

3.1 Implementing Polarized Deduction Modulo Theory

The implementation of Polarized Deduction Modulo Theory in a tableau-based theorem prover is one goal. The chosen tool is Zenon Modulo [DDG+13], that currently implements *unpolarized* Deduction Modulo Theory. This implementation will be assessed by intensive, industrial, benchmarks, through the TPTP library and the BWare platform [The12].

3.2 Learning Heuristics

To automatically solve a problem, it is of crucial importance to recognize patterns in the problems and to trigger the optimal proof mechanism.

A large body of problems is available, through the TPTP problem set or the BWare industrial platform [The12], we will train machine learning techniques on those sets.

A particular interest is to generate term instances that correspond to the problem to solve.

3.3 Proof Theory

This part involves the definition of models of Polarized Deduction Modulo Theory, for instance by refining the order relation that can be found in common algebras, but also in generalizing Kripke Structures, etc. The impact is soundness and completeness of the calculus wrt to the semantics, and in a second time to derive cut admissibility theorems in the spirit of [Oka99, BH06b, BH06a, LDM05].

Expressiveness of the logic, in particular the possibility to embed constraint [LN07] or higher-order systems [LDM05], can also be envisioned. This can result in the definition of new translations of logics in Dedukti, our proof-checker. A middle-term perspective is to adapt superconsistency [Dow06] to the polarized case.

3.4 Higher-Order Polarization

The polarized approach can be lifted to *type theory*. The goal here is to introduce polarized rewrite rules in a framework like the $\lambda\Pi$-calculus.

The asymetry brought up by polarized rewriting could be used to express subtyping, which is currently missing, and prevents us from expressing some systems. Moreover, it will make possible to double-check the proofs produced by Zenon Modulo.

Therefore an implementation of polarized rewriting in Dedukti [BCH12] is extremely desirable.

4 Required Background of the Student

This proposal are broad and deep, we do not expect a single PhD thesis to cover all these subjects. The focus on a specific area will depend on the applicant and his/her wishes.

An M.Sc.-level specialization in any field of computer science or mathematics is a strong requirement. More specialized courses, among which machine learning, logics (proof systems, proof assistants), rewriting, or functional programming are a plus.

References

[BBC+17] Guillaume Burel, Guillaume Bury, Raphaël Cauderlier, David Delahaye, Pierre Halmagrand, and Olivier Hermant. Automated deduction: When deduction modulo theory meets the practice. 44p. Submitted to Journal of Automated Reasoning., 2017.

[BCH12] Mathieu Boespflug, Quentin Carbonneaux, and Olivier Hermant. The $\lambda\Pi$-calculus modulo as a universal proof language. In *In Second Workshop on Proof Exchange for Theorem Proving (PxTP)*, volume 878, pages 28–43. CEUR-WS.org, 2012.

[BDD+15] Guillaume Bury, David Delahaye, Damien Doligez, Pierre Halmagrand, and Olivier Hermant. Automated deduction in the B set theory using typed proof search and deduction modulo. In Ansgar Fehnker, Annabelle McIver, Geoff Sutcliffe, and Andrei Voronkov, editors, *20th International Conferences on Logic for Programming, Artificial Intelligence and Reasoning - Short Presentations, LPAR 2015, Suva, Fiji, November 24–28, 2015*, volume 35 of *EPiC Series in Computing*, pages 42–58. EasyChair, 2015.

[BH06a] Richard Bonichon and Olivier Hermant. On constructive cut admissibility in deduction modulo. In Thorsten Altenkirch and Conor McBride, editors, *TYPES for proofs and programs*, volume 4502 of *Lecture Notes in Computer Science*, pages 33–47. Springer, 2006.

[BH06b] Richard Bonichon and Olivier Hermant. A semantic completeness proof for tableaux modulo. In Miki Hermann and Andrei Voronkov, editors, *LPAR 2006*, volume 4246 of *Lecture Notes in Computer Science*, pages 167–181, Phom Penh, Cambodia, November 2006. Springer-Verlag.

[Bur11] Guillaume Burel. Experimenting with deduction modulo. In Nikolaj Bjørner and Viorica Sofronie-Stokkermans, editors, *CADE*, volume 6803 of *Lecture Notes in Computer Science*, pages 162–176. Springer, 2011.

[DDG+13] David Delahaye, Damien Doligez, Frédéric Gilbert, Pierre Halmagrand, and Olivier Hermant. Zenon modulo: When achilles outruns the tortoise using deduction modulo. In Ken McMillan, Aart Middledorp, and Andreï Voronkov, editors, *LPAR*, volume 8312 of *LNCS ARCoSS*, pages 274–290. Springer, 2013.

[DHK03] Gilles Dowek, Thérèse Hardin, and Claude Kirchner. Theorem proving modulo. *Journal of Automated Reasoning*, 31:33–72, 2003.

[Dow06] Gilles Dowek. Truth values algebras and normalization. In Thorsten Altenkirch and Conor McBride, editors, *TYPES for proofs and programs*, volume 4502 of *Lecture Notes in Computer Science*, pages 110–124. Springer, 2006.

[Dow10] Gilles Dowek. Polarized deduction modulo. In *IFIP Theoretical Computer Science*, 2010.

[Ji15] Kailiang Ji. CTL model checking in deduction modulo. In Amy P. Felty and Aart Middeldorp, editors, *Automated Deduction - CADE-25 - 25th International Conference on Automated Deduction, Berlin, Germany, August 1-7, 2015, Proceedings*, volume 9195 of *Lecture Notes in Computer Science*, pages 295–310. Springer, 2015.

[LDM05] James Lipton and Mary De Marco. Completeness and cut elimination in Church's intuitionistic theory of types. *Journal of Logic and Computation*, 15:821–854, December 2005.

[LN07] James Lipton and Susana Nieva. Higher-order logic programming languages with constraints: A semantics. In Simona Ronchi Della Rocca, editor, *TLCA*, volume 4583 of *Lecture Notes in Computer Science*, pages 272–289. Springer, 2007.

[Oka99] Mitsuhiro Okada. Phase semantic cut-elimination and normalization proofs of first- and higher-order linear logic. *Theoretical Computer Science*, 227:333–396, 1999.

[The12] The BWare Project, 2012. `http://bware.lri.fr/`.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Chemistry, Physical Chemistry and Chemical Engineering, & Energy, Processes

Subfield: (Chemistry, Materials)

Title:Cophotolysis of water and carbon dioxide on doped TiO_2based aerogels for the production of solar fuels.

ParisTech School:MINES ParisTech

Advisor(s) Name: BEAUGER Christian
Advisor(s) Email:Christian.beauger@mines-paristech.fr
(Lab, website):*http://www.persee.mines-paristech.fr/Accueil/Presentation/*

Short description of possible research topics for a PhD:
In the context of the scheduled scarcity of fossil energy resources and increasing carbon dioxide emissions, it becomes imperative to make alternative fuels availablesuch as hydrogen or synthetic hydrocarbons. Today mainly produced from fossil carbon resources (by methane steam reforming and Fischer Tropsch process, for example), they will play a major role in the future energy mix only if they can be produced from viable processes from energetic, economic and environmental points of view. CO_2retroconversion and water photodissociation could separately fulfill this role.The proposed topic is based on the combination of these two processes to produce hydrogen and carbon monoxide, or eventually methanol, from photo-dissociation of carbon dioxide and water at the same time. The process will benefit from the efficiency of TiO_2 based aerogels to harvest UV radiation in order to dissociate water. Such materials will be modified by doping to increase their range of light absorption and efficiency. They will also be tested for CO_2retroconversion and cophotolysis of water and carbon dioxide.The work will build on the developments of the group in the field of photolysis of water on the one hand and the synthesis of aerogels on the other hand. It will include both materials and processes developments. It will consist in assessing the ability of the materials developed in the study to produce $H_2$and/or CO from H_2O and/or CO_2(preparation and characterization of TiO_2 aerogels, doping, theoretical and experimental study of the new process).

Required background of the student:
Good knowledge inmaterials science, chemical synthesis and characterization, solid physics. Knowledge in photochemistry would be appreciated.

A list of 5(max.) representative publications of the group: (Related to the research topic)

- BEAUGER et al., **Microporous and Mesoporous Materials**, 232 (2016) 109-118
- D'ELIA et al., **International Journal of Hydrogen Energy** 36 (2011) 14360-14373
- SUZUKI et al., **Journal of Nanoscience and Nanotechnology**, 9(256) (2008) 260, 2009
- SUZUKI et al., **NANO: Brief Reports and Reviews**, 3(5) (2008) 373–379

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering

Title: Multiscale study of polymer selective laser sintering (SLS) process: from characterization to numerical modeling

ParisTech School: Mines ParisTech

Advisors: Jean-Luc BOUVARD: jean-luc.bouvard@mines-paristech.fr

Yancheng ZHANG: yancheng.zhang@mines-paristech.fr

CEMEF: http://www.cemef.mines-paristech.fr/

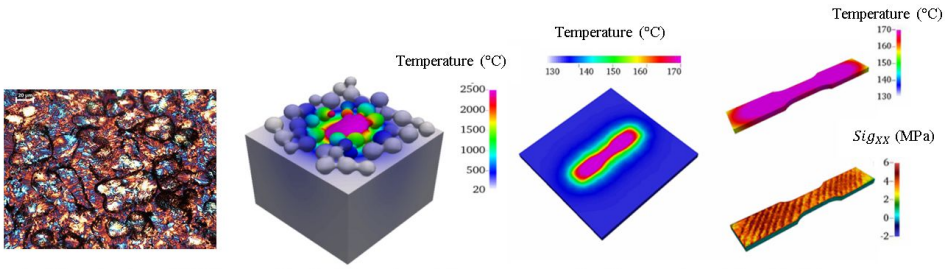
Short description of possible research topics for a PhD:

Additive manufacturing consists in building a part layer by layer directly from the data of a 3D computer-aided design model. Selective laser sintering (SLS) technique has become a viable technique for producing parts of short series and of complex shapes, not only on metals but also on polymers. But SLS process is relatively new and is not yet fully mastered. One of the main challenges is the ability of numerical tools to predict the relationship between the process and the final properties such as residual stress and/or final properties.

The Center of Material Forming (CEMEF), a Mines ParisTech research lab., has a strong expertise in polymer processing from fluid mechanics to solidification/crystallization and induced mechanical properties [1, 2, 3, 4]. The numerical teams have also developed a library based on Level Set methods to model at different scale SLS process. Such library is now applied for metallic component [5]. In this research project, we plan to extend such library to polymer material. In this thesis, a multi-scale study framework is proposed through two main tasks:

i) Studies of the influence of the manufacturing process on the final properties of the polymer and its microstructure (Figure 1 a).

ii) Numerical modeling of the SLS process for a polymer material at particle-scale for predicting the defects like porosities and at macro-scale (Figure 1 b) for predicting the distortion during (Figure 1 c) and post process.



a) Microstructure of PA12 SLS part (scale 20µm) b) Particle-scale model: temperature (IN718) c) Macro-scale model: residual stress (PA12)

Figure 1. Research on additive manufacturing developed at CEMEF

Required background of the student:

The candidate should have a master or engineer degree from mechanical engineering, mechanics or material science. Skills in heat transfer, solid mechanics, modelling and programming are required. Experiences on characterizing mechanical behavior or additive manufacturing are appreciated.

Publications of the group:

[1] A., Maurel-Pantel, E., Baquet, J., Bikard, J.L., Bouvard, N., Billon. A thermo-mechanical large deformation constitutive model for polymers based on material network description: Application to a semi-crystalline polyamide 66, International Journal of Plasticity, 67(2015):102-126.

[2] N. Billon, J.L. Bouvard, Properties and mechanical behavior of thermoplastic polymer, Techniques de l'Ingénieur, 26 p., 2015, Référence AM3115.

[3] J.M. Haudin, S.A.E. Boyer, Crystallization of Polymers in Processing Conditions: An Overview. International Polymer, 32(2016): 545-554.

[4] L. Freire, C. Combeaud, N. Billon, J-M. Haudin, “An analysis of transcrystallinity in polymers”, AIP Conf. Proc. 1695, 020010; http://dx.doi.org/10.1063/1.4937288 (2015)

[5] Y. Zhang, G. Guillemot, M. Bernacki, M. Bellet, Macroscopic thermal finite element modelling of additive metal manufacturing by selective laser melting process, Computer Methods in Applied Mechanics and Engineering 331 (2018): 514–535.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):***
5 Environment Science and Technology, Sustainable Development, Geoscience
9. Mathematics and their applications
Subfield: (
Precipitation, remote sensing
Statistics, stochastic processes

Title: Precipitation stochastic forecasts based on high resolution radar data, applications to olympic games

ParisTech School: Ecole des Ponts ParisTech

Advisor(s) Name: Daniel SCHERTZER
Advisor(s) Email: Daniel.Schertzre@enpc.fr
(Lab, website): laboratoire Hydrologie Météorologie et Complexité (HM&Co)
https://hmco.enpc.fr

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
We are witnessing the deployment of the recent technology of polarimetric X band radar, especially around large cities. It is already strongly advanced around the 10 largest cities of Japan. This technology makes it possible to obtain a factor 10 in spatial resolution, a greater measurement sensitivity and hydro-meteorological radars much more compact and therefore significantly less expensive.
New short term forecasts (nowcasts) need to be developed to take advantage of this technology at its full extent. It is proposed to develop stochastic nowcasts based on multifractal cascade processes that enable to be as close as possible to the intrinsic limit of predictability. The Olympic Games of 2020 (Tokyo) and 2024 (Paris) will be important cases of experimentation to which this thesis will contribute.

Required background of the student: (Which should be the main field of study of the applicant before applying)
Some familiarity with hydro-meteorology and/or with stochastic processes. A first part of the thesis will be devoted to update knowledge in both domains.

A list of 5(max.) representative publications of the group: (Related to the research topic)
Lovejoy, S. and Schertzer, D. (2013) The Weather and Climate: Emergent Laws and Multifractal Cascades. Cambridge U.K.: Cambridge University Press. p.1-491

Ochoa-Rodriguez, *et al.*, D. Schertzer, 2015: Impact of spatial and temporal resolution of rainfall inputs on urban hydrodynamic modelling outputs: A multi-catchment investigation. *Journal of Hydrology*, 531(2), 389–407.

Paz, I., *et al.* and Schertzer, D. (2018), Multifractal comparison of reflectivity and polarimetric rainfall data from C- and X-band radars and respective hydrological responses of a complex catchment model, Water, 10, 269.

Schertzer, D., I. Tchiguirinskaia, S. Lovejoy, 2012. Getting higher resolution rainfall estimates: X-band redar technology and multifractal drop distribution. In R. J. Moore, ed. *Weather Radar and Hydrology*. Walingford, U.K.: IHAS Press, pp. 105–110.

Schertzer, D. and Tchiguirinskaia, I.,(2017), An Introduction to Multifractals and Scale Symmetry Groups, in Fractals: Concepts and Applications in Geosciences. Ghanbarian, B. and Hunt, A. (eds) CRC Press, 1-28.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):***
9. Mathematics and their applications 10. Physics, Optics

Subfield:
Stochastic processes, symmetry groups. Hydrodynamics.

Title: Analysis and simulations of extremely variable vector fields

ParisTech School: Ecole des Ponts ParisTech
Advisor(s) Name: Daniel SCHERTZER
Advisor(s) Email: Daniel.Schertzer@enpc.fr
(Lab, website): laboratoire Hydrologie Météorologie et Complexité (HM&Co)
https://hmco.enpc.fr

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
The fast deployment of low-cost and more accurate measurement devices have paved the way to high resolution turbulent wind fields, in particular short term forecasting, e.g. for wind energy. Unfortunately, the conventional observables used so far for statistical data analysis, as well as for stochastic modelling, have been scalar ones (e.g., the ubiquitous "structure functions").
On the contrary, there had been recent developments on multifractal vectors based on the stochastic algebra of their generators that theoretically overcome these shortcomings. However, even in the case of what seems to be the simplest case, i.e. Levy-Clifford algebra, there a large number of parameters, therefore of theoretical choices to be done. This thesis will therefore first investigate the extensions to the vector case of multifractal analysis techniques and apply them to various data sets to get some empirically based choices among various candidates. This will enable to proceed to simulations and stochastic short term forecasts (nowcasts).

Required background of the student: (Which should be the main field of study of the applicant before applying)
Ideally a background on both stochastic processes and hydrodynamics, with some insights on symmetry groups. A first part of the thesis will be devoted to update knowledge in those domains, if needed.

A list of 5(max.) representative publications of the group: (Related to the research topic)
Lovejoy, S. and Schertzer, D. (2013) The Weather and Climate: Emergent Laws and Multifractal Cascades. Cambridge U.K.: Cambridge University Press. p.1-491.
Schertzer, D., Tchiguirinskaia, I., Lovejoy, S. and Tuck, A. F. (2012) 'Quasi-geostrophic turbulence and generalized scale invariance, a theoretical reply', Atmos. Chem. Phys., 12, pp. 327–336.
Schertzer, D. and Tchiguirinskaia, I. (2015) 'Multifractal vector fields and stochastic Clifford algebra', Chaos: An Interdisciplinary Journal of Nonlinear Science, 25(12), p. 123127. doi: 10.1063/1.4937364.
Schertzer, D. and Tchiguirinskaia, I.,(2017), An Introduction to Multifractals and Scale Symmetry Groups, in Fractals: Concepts and Applications in Geosciences. Ghanbarian, B. and Hunt, A. (eds) CRC Press, 1-28.
Schertzer, D. and Tchiguirinskaia, I. (2018) 'Pandora Box of Multifractals: Barely Open ?', in Tsonis, A. A. (ed.) Advances in Nonlinear Geosciences. Cham: Springer, pp. 543–563. doi: https://doi.org/10.1007/978-3-319-58895-7_25.

Research Topic for the ParisTech/CSC PhD Program

Field: *Information and Communication Sciences and Technologies, Mathematics and their applications*

Title: NOMA based transmission optimization with low latency

ParisTech School: Telecom ParisTech

Advisor(s) Name: Prof. Philippe CIBLAT
Advisor(s) Email: *philippe.ciblat@telecom-paristech.fr*
(Lab, website): *LTCI, http:perso.telecom-paristech.fr/~ciblat/*

Short description of possible research topics for a PhD:

Demands in high data rate, reliable and low latency communications are increasing due to the huge development of new wireless applications (gaming, virtual reality, etc). In order to fulfill these new requirements, we cannot resort to traditional schemes waiting for an acknowledgment feedback with delay. We need to force the transmitter to send information enough on time. The idea is to do superposition coding between several bit streams by mimicking the Non-Orthogonal Multiple Access (NOMA), which is a candidate for 5G multiple access but also has rich perspectives in the longer term..

The topic is of equally-large interest to academia as to industry. However, before the idea of combininig retransmission scheme with superposition coding and successive interference canceler could be implemented into real systems, the following questions have to be addressed:

- What is the performance of such a new scheme (either with theoretical capacity-achieving coding or practical coding)? More precisely, what are the performance improvements in terms of throughput, delay?
- What is the benchmark performance? Assuming feedback delay and successive interference canceler, what is the best throughput?
- Which practical scheme has to be selected?
- Once this system has been optimized, how to manage multi-user interference and related resource allocation?

The goal of this PhD thesis is to find answers to these questions. We expect that information theory and signal processing will be relevant tools to find appropriate solutions.

Required background of the student: Digital Communications, Wireless networks, Signal Processing, Statistics, Information Theory

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] A. Khreis, **P. Ciblat**, F. Bassi, and P. Duhamel : *Multi-Packet HARQ with delayed feedback*, IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Bologna (Italy), September 2018.
[2] A. Khreis, **P. Ciblat**, F. Bassi, and P. Duhamel : *Throughput-efficient Relay assisted HARQ*, International Symposium on Wireless Communication Systems (ISWCS), Lisbon (Portugal), August 2018.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Information and Communication Sciences and Technologies

ParisTech School: Telecom ParisTech

Title: Quantification of antenna uncertainties in uncontrolled environments and impact on (5G and beyond) wireless networks

Advisor(s): Joe Wiart (joe.wiart@telecom-paristech.fr) and
Christophe Roblin (christophe.roblin@telecom-paristech.fr).
https://www.telecom-paristech.fr/eng; http://chairec2m.mines-telecom.fr

Short description of possible research topics for a PhD:

The future 5G and beyond networks will use dense architectures and single/multiple antennas for MIMO and massive MIMO systems. Wireless devices will be operating in uncontrolled conditions because of the variability and the lack of knowledge of the characteristics of their close electromagnetic environment. This brings new issues for the management of the uncertainties of the antenna properties and their impact on network performance. Traditionally indeed, antennas are considered as deterministic objects, operating in fixed environments and with sufficiently known characteristics. The high degree of variability of the radio channel is usually only involved in the propagation channel. Such a conventional approach does not allow quantifying and mastering the impact of antenna uncertainties on the network key performance indicators (KPIs).
The objective of this thesis is thus to develop innovative statistical models of environed antennas, able to much better describe the true performance of single or multiple antennas. Spherical Modes Expansion and surrogate modeling (e.g. Chaos Polynomials Expansion or Low Rank Tensor Approximation) will in particular be used to build parsimonious and compact surrogate models. These environed antenna models will then be used in network deterministic design tools as well as in statistical radio channel models, to quantify the impact of such a variability on the KPIs.
The work will take advantage of existing scientific collaborations between the C2M research Chair at Telecom ParisTech and two major High Tech companies: Micro Wave Vision (MVG) on near field measurement and SIRADEL on propagation and network planning tools.

Required background of the student: The student must have a good background in Electromagnetism, radio propagation, antennas, and adequate knowledge in telecommunications and statistical methods

List of 5 representative publications of the group:

- Y. Y. Huang & J. Wiart, *Simplified Assessment Method for Population RF Exposure Induced by a 4G Network*, IEEE JREM, Sept 2017.
- Jinxin Du and C. Roblin, *Stochastic Surrogate Models of Deformable Antennas based on Vector Spherical Harmonics and Polynomial Chaos Expansions: Application to Textile Antennas*, IEEE Transactions on Antennas and Propagation, vol. 66, n° 7, July 2018, pp. 3610-3622.
- P. Kersaudy, B Sudret, N. Varsier, O Picon, J Wiart, *A new surrogate modeling technique combining Kriging and polynomial chaos expansions. Application to uncertainty analysis in computational dosimetry*, Journal of Computational Physics, 2015.
- RK Arya, P Kersaudy, J Wiart, R Mittra, *Statistical Analysis of Periodic Structures and Frequency Selective Surfaces using the Polynomial Chaos Expansions*, e-fermat. 2015.
- A. Sibille, C. Roblin, S. Bories and A.-C. Lepage, *A Channel-Based Statistical Approach to Antenna Performance in UWB Communications*, IEEE Transactions on Antennas and Propagation, vol. 54, n° 11, pp. 3207-3215, Nov. 2006.

Research Topic for the ParisTech/CSC PhD Program

Subfield: Information and Communication Sciences and Technologies
ParisTech School: Telecom ParisTech
Title: **Uncertainty quantification and surrogate modeling in high dimensional spaces using machine learning**
Advisor(s): Joe Wiart, (Joe.wiart@telecom-paristech.fr,)
http://chairec2m.mines-telecom.fr

Short description of possible research topics for a PhD:

The proposed research is dealing with computational simulation and Uncertainty Quantification (UQ) in high dimensional spaces using machine learning and surrogate modeling (e.g. chaos polynomial approaches).

Thanks to progress in high performance calculation, simulation tools are nowadays increasingly used to design complex systems, such as advanced 5G antennas, or to assess human exposure. In such a context uncertainty quantification is an important task since some parameters are unknown or highly uncertain. Despite the progress in high performance computation, the Monte Carlo method, which is independent of the number of stochastic dimensions, is unsuitable for UQ because of expensive computer codes and the need of a large number of samples.

A large effort has seen spent in the last decade to construct a cheap-to-evaluate surrogate model to replace the forward model solver. Gaussian processes, generalized polynomial chaos expansions, low rank tensor approximation, radial basis functions and support vector machines have been investigated. Despite their success, these methods are facing limits for problems having a large number of input parameters, which is often the case for real physical systems. In such a case, one has to deal with the curse of dimensionality, in which the volume increases exponentially with the number of parameters. Many common dimensionality reduction techniques try to project the high dimensional inputs onto a low-dimensional subspace, which captures most of the information of the original input. The main limit of such a method is its unsupervised character, which is only looking at samples of the input, ignoring information contained in the model outputs. This approach tends to overestimate the effective dimensionality of the system.

To overcome such limitations, efforts have been carried out to build greedy surrogate model using for instance low rank tensor approximations as well a sparse model approaches (such as LARS), in order to identify the terms having most influence. These approaches have been successfully implemented but they are still facing limits in the case of a very large number of input parameters.

To overcome such a limitation, the objective of the PhD research is to investigate the use of polynomial chaos expansions or low rank tensor approximation combined with deep machine learning, neural network and artificial intelligence, so to perform a dimension reduction taking into account information contained in the model outputs.

Required background of the student: The student must have a good background in computational physic and statistics. A background in electromagnetism and wireless communications will be appreciated

List of 5 representative publications of the group:

(1) Kersaudy, B Sudret, N - Varsier, O Picon, J Wiart "A new surrogate modeling technique combining Kriging and polynomial chaos expansions. Application to uncertainty analysis in computational dosimetry" Journal of Computational Physics, 2015
(2) Y. Y. Huang & J. Wiart "Simplified Assessment Method for Population RF Exposure Induced by a 4G Network" IEEE J.R.E.M. Sept 2017
(3) Soumaya Azzi,_, Yuanyuan Huang, Bruno Sudret, Joe Wiart "Surrogate Modeling of Stochastic Functions -Application to computational Electromagnetic Dosimetry" arxiv 2018
(4) Zicheng Liu, Dominique Lesselier, Bruno Sudret, Joe Wiart "Surrogate modeling based on resampled polynomial chaos expansions" Arxiv 2018
(4) RK Arya, P Kersaudy, J Wiart, R Mittra "Statistical Analysis of Periodic Structures and Frequency Selective Surfaces using the Polynomial Chaos Expansions " e-fermat. 2015

Research Topic for the ParisTech/CSC PhD Program

Field: Information and Communication Sciences and Technologies

Subfield: (Digital Electronics, Computer Science)

ParisTech School: Telecom ParisTech

Title: Selective Approximation for Low Energy Convolutional Neural Networks.

Advisor(s): Sumanta Chaudhuri (sumanta.chaudhuri@telecom-paristech.fr;)
website: https://perso.telecom-paristech.fr/~chaudhur/

Lirida Naviner (lirida.naviner@telecom-paristech.fr)
website: https://perso.telecom-paristech.fr/~lnaviner/

Short description of possible research topics for a PhD:
The main goal of this PhD. Thesis will be ultra-low energy implementation of deep learning algorithms. To this end we would like to use Binarized Neural networks where both the activations and weights of a Convolutional Neural network (CNN) are quantized to binary values (0,1). This leads to very efficient implementations in silicon using XNOR gates instead of multipliers. However there is a price to pay in terms of accuracy as it will lower the accuracy of predictions.
As a method to optimize Binarized neural networks the goal of this Phd. Thesis wil be to use selective binarization. That is, we run experiments on a given CNN (K layers), and find out which layers we can binarize without affecting the accuracy significantly. Furthermore, we would like to attribute a specific quantization level for each layer. (e.g layer One: 9bits, layer Two: 1 bit, layer Three: 16 bits etc..) with the goal of optimizing a combined metric of "Power Consumption" of "Accuracy". The target application for our network (ApproxiNet) is unmanned drones tracking target objects, so power consumption is a very important criteria.

Required background of the student:
Software Engineering, Algorithms, Probability & Statistics, Digital Electronics.
Desired: Hands-on experience of open-source software development with Python.

A list of 5 (max.) representative publications of the group:

[1] Hao Cai, You Wang, Lirida Alves de Barros Naviner, and Weisheng Zhao. Approximate computing in mos/spintronic non-volatile full-adder. In Proceedings of ACM/IEEE International Symposium on Nanoscale Architectureseedings of ACM/IE, Beijing, China, July 2016.

[2] Hao Cai, You Wang, Lirida Alves de Barros Naviner, and Weisheng Zhao. Robust ultra-low power non-volatile logic-in-memory circuits in FD-SOI technology. IEEE Transactions on Circuits and Systems I: Regular Papers, 64(4):847--857, November 2016.

[3] Olivier Morillot, Laurence Likforman-Sulem, Emmanuèle Grosicki: New baseline correction algorithm for text-line recognition with bidirectional recurrent neural networks. J. Electronic Imaging 22(2): 023028 (2013)

[4] Cristina Oprean, Laurence Likforman-Sulem, Adrian Popescu, Chafic Mokbel: Handwritten word recognition using Web resources and recurrent neural networks. IJDAR 18(4): 287-301 (2015)

[5] Francisco Veirano, Fernando Silveira, Lirida A. B. Naviner: Minimum Operating Voltage Due to Intrinsic Noise in Subthreshold Digital Logic in Nanoscale CMOS. J. Low Power Electronics 12(1): 74-81 (2016)

Research Topic for the ParisTech/CSC PhD Program

Field: Information and Communication Sciences and Technologies

Subfield: Optoelectronics, physics of solid-state lasers

Title: **High-speed quantum dot lasers on germanium/silicon for short communication links**

ParisTech School: Telecom ParisTech

Advisor: Prof. Frédéric Grillot, grillot@telecom-paristech.fr

Website: http://perso.telecom-paristech.fr/~grillot/

Short description of possible research topics for a PhD

Silicon photonics has been a very active area of research for more than 2 decades, targeting at integrating both active and passive photonic and optoelectronic devices on a single silicon chip (laser sources, modulators, photodetectors, waveguides, filters, and optical switches). The greatest challenge is to integrate monolithically III-V semiconductor lasers on germanium or silicon (Ge/Si), due to epitaxial defects originating from the crystal lattice mismatch. Luckily, InAs/GaAs quantum dot (Qdot) lasers are weakly sensitive to such defects, and CW lasing of Qdot lasers grown on Ge/Si at 300K have been demonstrated. Qdot lasers exhibit superior characteristics such as low threshold current and large temperature stability, which is very useful for low energy consumption photonic integrated circuits. Recent work showed that Ge-based Qdot lasers could also exhibit a reduced noise in comparison with GaAs-based Qdot lasers, but a comprehensive understanding is still missing. This project will focus on physical modeling and experiments on InAs/GaAs Qdot lasers on Ge/Si. Phase noise modeling will be implemented both semi-analytically and numerically. Various characterizations will be performed, including spectral linewidth and power spectral density of flicker & white noise. The work will also address methods to reduce phase noise, such as photonic / optoelectronic perturbations (e.g. external optical feedback).

The thesis will be conducted in close collaboration with Dr. Cheng Wang at ShanghaiTech University (http://shanghaitech-sist-chengwang.myfreesites.net/).

Required background of the student:

Solid background in lasers/semiconductor optoelectronics ; communication and reporting skills.

2-3 representative publications of the group

[1] M. T. Crowley, N. A. Naderi, H. Su, F. Grillot and L. F. Lester, "GaAs based Quantum Dot Lasers", Semiconductors and Semimetals: Advances in Semiconductor Lasers, Vol. 86, (2012).

[2] Y. G. Zhou, C. Zhou, C. F. Cao, J. B. Du, Q. Gong, and C. Wang, "Relative intensity noise of InAs quantum dot lasers epitaxially grown on Ge," submitted Opt. Express, (2017).

[3] K. Schires, S. Gomez, A. Gallet, G. H. Duan, and F. Grillot, Passive chaos bandwidth enhancement under dual optical feedback with hybrid III-V/Si DFB lasers, IEEE Journal of Selected Topics in Quantum Electronics, vol. 23, pp. 1801309, (2017).